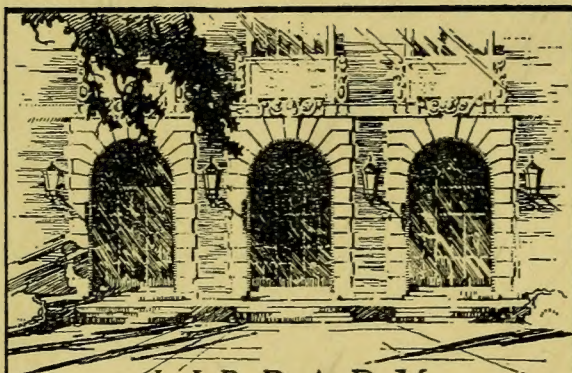


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1932-1935

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NATURAL HISTORY SURVEY DIVISION

THEODORE H. FRISON, *Chief*

URBANA, ILLINOIS
NOVEMBER 1935

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CONTENTS

ARTICLE I.—INITIAL STUDIES OF AMERICAN ELM DISEASE IN ILLINOIS. BY HUBERT A. HARRIS. October 1932.	
70 pp., 35 figs.....	1-70
Introduction 1, Acknowledgments 2, Scope of present report 3, Previous outbreaks of elm disease in Illinois 3, Character of the present elm malady 6, Methods 9, General results of cultural tests 15, Specific diseases 20, Other infections 50, Inoculation trials 58, Preliminary control experiments 59, Summary 67, Literature cited 67.	
ARTICLE II.—A SURVEY OF THE FISHERY OF THE KASKASKIA RIVER. BY WILBUR M. LUCE. August 1933. 53 pp., 12 figs.....	
	71-123
Introduction 71, Hydrography 74, Personnel 80, Methods and equipment 80, The value of the fishery 83, Kinds and numbers of mussels 86, Kinds of fishes caught with various tackle 87, Factors affecting the abundance of fishes in the Kaskaskia 89, The rate of growth in fishes 93, The fishes of the Kaskaskia 94, Literature cited 121.	
ARTICLE III.—THE DERMAPTERA AND ORTHOPTERA OF ILLINOIS. BY MORGAN HEBARD. November 1934. 155 pp., 167 figs.....	
	125-279
Biology and habits of the orders 125, Ecological factors affecting Orthoptera 128, Summary of literature 134, Collection and disposition of the material 135, Use of the keys 140, Key to the orders 150, Dermaptera 151 [See supplementary page 150A], Orthoptera 151, Bibliography 259, Appendix 266.	
ARTICLE IV.—THE STONEFLIES, OR PLECOPTERA, OF ILLINOIS. BY THEODORE H. FRISON. January 1935. 191 pp., 344 figs.....	
	281-471
Foreword iii, Status of the group 281, Stonefly structure 285, Biology of the order 288, Collecting, rearing and preserving stoneflies 303, Catalog of species, including classification, description, habits and records of Illinois stoneflies 307, Bibliography 461, Index 468.	
ARTICLE V.—ANNOTATED LIST OF THE FISHES OF ILLINOIS. BY D. JOHN O'DONNELL. August 1935. 28 pp., 4 figs.....	
	473-500
Introduction 473, Classified list of Illinois fishes 475, Bibliography 491, Appendix 492.	
INDEX.....	501

EMENDATIONS

1. Page 2, subhead. For ACKNOWLEDGEMENTS read ACKNOWLEDGMENTS.
2. Page 98, line 8, For May read Many.
3. See supplementary page 150A for additional Dermaptera.
4. Page 162, couplet 5, and pp. 168-ff. For *Acridium* read *Acrydium*. In index p. 270, same.
5. Page 226, line 2. For *Rhaphidorphora* read *Rhaphidophora*. In index, p. 270, same.
6. Page 249. For number of the illustration, **Fig. 116**, read **Fig. 161**.
7. Page 254. In explanation of Fig. 163, for *Oceanthus* read *Oecanthus*.
8. Page 392. For page number 92 read 392.
9. Page 460, lines 18, 19 from bottom. For Description read Descriptions.
10. Page 480, column 1, second subhead. For **Hagochila** read **Lagochila**. Following line, for **H. lacera** read **L. lacera**. In index, p. 495, same.

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THEODORE H. FRISON, *Chief*

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Article I

Initial Studies of American Elm Diseases in Illinois

HUBERT A. HARRIS



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CONTENTS

	PAGE
INTRODUCTION	1
ACKNOWLEDGMENTS	2
SCOPE OF PRESENT REPORT.....	3
PREVIOUS OUTBREAKS OF ELM DISEASE IN ILLINOIS.....	3
CHARACTER OF THE PRESENT ELM MALADY.....	6
Importance in Nurseries.....	9
Importance in Cities.....	9
METHODS	12
Isolation of Fungi from Diseased Wood.....	12
Culturing Fungi from Spores.....	12
Histological Technique	13
Recording Data	14
GENERAL RESULTS OF CULTURAL TESTS.....	15
SPECIFIC DISEASES	20
Tracheomycosis Associated with Coniothyrium spp.....	20
Vermicularia Disease	38
Phoma Cankers	41
Sphaeropsis Dieback and Canker.....	45
Phomopsis Canker	45
Verticillium Wilt	48
OTHER INFECTIONS	50
Fusaria	50
Cephalosporium	51
Alternaria and Stemphylium.....	51
Anthostomella	52
Cytospora Canker	52
Diplodia Canker	53
Nigrospora	54
Xylaria	55
Other Fungi	57
Bacteria	58
INOCULATION TRIALS	58
PRELIMINARY CONTROL EXPERIMENTS.....	59
Experiment No. 1.....	61
Experiment No. 2.....	63
Relation to the Problem of Control.....	65
SUMMARY	67
LITERATURE CITED	67

Initial Studies of American Elm Diseases in Illinois

HUBERT A. HARRIS

INTRODUCTION

THE diseases of the American elm (*Ulmus americana* L.), like those of most trees grown for ornament and shade, have not been extensively investigated in America. Two diseases of minor importance in most years, the leaf spot caused by *Gnomonia ulmea* (Sacc.) Thuem. and the anthracnose caused by *Mycosphaerella Ulmi* Kleb., have attracted attention, as have also some wood rots. The list of fungi thus far recorded upon the American elm in this country includes, according to Seymour (1929)¹, 112 species, but the majority of them are of only scientific interest.

When the dying of elms began recently to attract attention in Illinois, it was suspected by some that the cause of their dying might be the Dutch elm disease. The investigations of Westerdijk and Buisman in Holland were published in 1929, and subsequently wide publicity was given to the destructive character of the Dutch elm disease. To anyone not acquainted with the technical aspects of tree pathology and not practiced in the diagnosis of tree diseases, both external and internal manifestations of the prevalent American elm malady would be very difficult to distinguish from the reported symptoms of the Dutch elm disease, as may be understood from the fact that the American malady is often called "elm wilt." That May (1930) found the Dutch elm disease in Ohio during the summer of 1930 served, of course, to add emphasis to the possibility that elms in Illinois were affected by it.

However, even before an investigation was undertaken, it was indicated that diseased elms in Illinois were not suffering from the Dutch elm disease. In the summer of 1930 Dr. Buisman, who was then making a tour of the United States to study elm diseases, examined a number of diseased elms in Illinois. After having seen typical material in nurseries, in city parkways and in private plantings, she was of the

¹ References in this work made by author and year, p. 67, Literature Cited.

opinion that though the malady was unknown to her it certainly was not the Dutch elm disease.

It has therefore remained for us to confirm Dr. Buisman's opinion, by both microscopical and cultural laboratory procedure, and to establish the real nature of the malady. From none of the many diseased elm trees examined by us have we secured *Graphium Ulmi* Schwarz or its ascigerous stage, *Ceratostomella Ulmi* Buisman (1930), the fungus which causes the Dutch elm disease.

ACKNOWLEDGEMENTS

DURING the course of the work herein reported, the writer has had the cordial and helpful assistance of several persons, to all of whom he wishes to extend his thanks and appreciation. P. A. Glenn, Chief Plant Inspector for the State of Illinois, has given his personal help in advocating the prosecution of these studies and in furnishing diseased material personally and through several of his assistants. He has also made available his intimate knowledge of nursery conditions in connection with the prevalence of disease and in selection of the plantations used in our preliminary control studies. Mrs. Thelma Alexander of the Ohio Agricultural Experiment Station rendered excellent assistance, in the early stages of the investigation, in the preparation of wood sections for microscopical examination, as attested by the photomicrograph, figure 11, page 24. Leo Campbell, formerly of the botany department of the University of Illinois, assisted in the culturing of fungi during the summer of 1931. Dr. C. D. Sherbakoff has examined and identified for us specimens of *Fusarium*. Ray R. Hamm deserves special thanks for his willing coöperation in producing the fine photographic illustrations. The Illinois State Nurserymen's Association and its secretary, Miles W. Bryant, have rendered many services, notable among which is the establishment for us of a one-quarter acre experimental elm nursery. The Swain-Nelson and Freeman nurseries have coöperated splendidly in the preliminary control experiments by allowing the use of special elm blocks and by contributing labor and equipment. Thanks are due Dr. John T. Buchholz of the Department of Botany, University of Illinois, for suggestions in the making and staining of microscopic wood sections and for the use of micro-projection apparatus. The investigation has been conducted under the supervision of L. R. Tehon, Botanist of the NATURAL HISTORY SURVEY. The writer owes him much for the invaluable suggestions and criticism offered, and the constant personal interest manifested throughout the work.

SCOPE OF PRESENT REPORT

A PLANT disease epidemic is difficult enough to combat when the cause of the disease is known, but when it is unknown, as in the case of this elm malady, the problem is even more serious. As the prevalence of this elm malady in Illinois was steadily increasing year after year, it became obvious that immediate steps were required to prevent an epidemic which might prove very destructive to the elms of the state. In the latter part of September 1930, the ILLINOIS STATE NATURAL HISTORY SURVEY undertook an investigation of the elm malady. This was done at the request of the state's Chief Plant Inspector, whose desire in this regard was endorsed by the Illinois State Nurserymen's Association.

This paper is a report of the first results of the investigation. It includes an account of previous work on Illinois elm diseases, the importance of the present malady in nurseries and cities, the general symptoms manifested by diseased elms in Illinois, a detailed consideration of symptoms, effects, and probable pathogens for several important and minor diseases and of fungi obtained infrequently, as well as an account of two preliminary experiments relating to the control of "elm wilt" in nurseries.

It is realized that much more experimentation is necessary to complete our knowledge of the elm malady and especially to develop control measures more adequate than those reported herein. It is not, therefore, intended that the facts given here shall be taken as complete and absolute, but instead that they are the best statements regarding the Illinois "elm wilt" that can be made at this time.

PREVIOUS OUTBREAKS OF ELM DISEASE IN ILLINOIS

DYING of elms is not a new occurrence in Illinois. Elm diseases have attained considerable importance and have received recognition at various times during the past fifty years. The first investigator to direct his attention to the problem was Dr. S. A. Forbes (1885) who, as State Entomologist, observed a dying of elms for several years prior to 1883. When, in that year a general destruction of elms occurred throughout central Illinois, an investigation to determine its cause was begun. The trouble was at that time thought to be entomological in nature, and Forbes, in his report, attributed it to injury inflicted by the elm borer (*Saperda tridentata* Olivier). Twenty-seven years later Forbes (1912) directed attention to a similar elm malady which had centered this time chiefly in the southern and western parts of the state. While the ultimate death of the elms was occasioned by elm borers, they apparently attacked trees only after a weakened condition had resulted from improper care, from a lack of sufficient moisture supply, or from improper fertilization.



Fig. 1.—A diseased American elm. This shade tree is very severely infected, as is evident from the great number of dead twigs and branches. Photographed July 8, 1931.

Outbreaks quite similar to those described by Forbes were reported by Garman (1899) to have occurred in Massachusetts in 1847 and in Kentucky in 1892.

In 1913 Humphrey noticed an unthrifty and apparently diseased condition of elms at Rockford, Illinois. In several trees the tops were dead, and limbs were frequently seen which had died back for distances of 10 to 15 feet from the tip. A sloughing off of the bark which occurred in some cases was limited to small areas at the base of the trunk. The cambium beneath these areas was still alive except in a very limited area. Humphrey concluded that the trouble was due to severe winter injury, since no signs of parasitic fungi were visible and only a very few elm borers were present.



Fig. 2.—A diseased American elm, showing the appearance of “elm wilt” in nursery stock. The disease has caused a general blighting of small twigs and branches throughout the tree. Photographed October 17, 1931.

The view that all past elm troubles have been due entirely to insects or environmental injury cannot be entertained now. Fungous organisms capable of attacking elms and causing their death undoubtedly existed then, as they do now. In fact, these early investigators cited examples of trees which, although entirely dead showed not the slightest trace of insect attack or injury. These trees did, however, have their inner bark discolored though intact, and the discoloration as these workers described it is now accepted, on the basis of a much fuller knowledge of tree pathology, as a very common and characteristic symptom of fungous parasitization of woody plant tissue.

CHARACTER OF THE PRESENT ELM MALADY

CERTAIN general symptoms are exhibited by diseased elms, by means of which the fact that they are diseased can very readily be ascertained. Most obvious is the presence of dead limbs, branches or twigs. These may occur in any part of the tree, but usually they stand out prominently in the top or toward the ends of large branches. There may, however, be only a general blighting or dying of twigs on one or more branches; or the indication of disease may be found in the tendency of the leaves on one or more branches to wilt.

An advanced stage of disease is exhibited by the elm shown in figure 1. Limbed against the sky, the dead, leafless twigs and branches show abundantly throughout the top of the tree, and a large open space in the left side of the tree shows where disease has killed a large branch. The immediate result, as the picture shows, is to ruin the beauty of the tree. Its value, and the value of the property on which it stands, are both decreased. In three or, at most, four years, the tree will die.

In nursery stock the general symptoms of disease are very similar to those shown by older trees. Young twigs die and the leaves fall from them. Usually this occurs first toward the ends of lateral branches, less frequently at the end of leaders, but in severe cases, or in trees infected for one or more seasons, it may take place throughout the tree. Such a case is shown in figure 2, and the result of continued progress of the disease is illustrated by the nursery tree shown in figure 10.

One outstanding characteristic of the so-called "elm wilt," as it appears in nursery trees, is shown in figure 3. Though the manner in which infection gains entrance to the tree is not known, the disease apparently begins in the young growth of the current year. New twigs die from the tip backward, and there is much similarity in their dying to the progress of a true wilt. The progress and nature of the disease may, perhaps, best be illustrated by reproducing here notes made June 25, 1931, on the tree from which the diseased twig shown in figure 3



Fig. 3.—Tip of a lateral branch, showing the manner in which the presence of disease is first manifested. Crooking of the twig tips and retention of the end leaves are typical early symptoms. Only the terminal part of the lowest twig has become infected, as is indicated by the presence of healthy leaves toward its base. Photographed June 27, 1931. $\times \frac{1}{2}$.

was taken for photographing.

"The type of malady shown this summer is striking in that twigs and branchlets arising from the laterals and trunk in all parts of the tree die back from the tips. The terminal growth is killed, and frequently the end leaf clings to the twig, though the other leaves soon fall off. The season's growth soon becomes dead and dry and is typically curved backward so as to resemble a shepherd's crook. It is not apparent where the infection took place, but the indications are that the buds from which the new twigs sprang served as an infection court or that the infection might have gained entrance by way of the axils of the new leaves.

"These newly diseased twigs show internal evidence of infection only toward their tips and, when cut off at the laterals from which they spring, show no indication of diseased wood (at this date) at the point of severance.

"Leaves of these blighted spurs at first turn yellow at the tip, then wilt, and eventually become withered, brown and brittle. They cling for a while to their twigs but eventually all but the end leaf fall."

In addition to the general symptoms just described, other signs of disease may be found by examining the trees closely. One of these is the presence of cankers on limbs and twigs. These cankers may vary widely in their external appearance. They may be smooth and raised, like the one shown in figure 4A, or they may be sunken and rough as in figure 7A. Often they extend lengthwise along one side of the stem, but often, also, they encircle and girdle the stem. Whether they extend over a considerable area or are limited to a small portion of the stem is of importance in distinguishing specific diseases. This is also true of the color which the various kinds of cankers exhibit. Another feature of these cankers, and one which indicates with certainty that the elm branch is attacked by a fungus, is the presence of small, pimple-like eruptions, such as those shown in figure 4B. A number of fungi that cause disease in the elm produce their spores in fructifications of this kind. Sometimes these pustules are so small that they may be entirely overlooked unless a magnifying glass is used.

The most definite and characteristic symptom shown by an elm parasitized by a fungus is discoloration of the wood (see figures 5, 7, 9, 21 and 27). The character and appearance of this discoloration varies, as do the cankers, with the particular kind of fungus causing the disease. After the bark is removed from an affected stem, especially from the cankered side if a canker is present, a brownish discoloration of the wood may be seen. This discoloration may not extend deeply into the wood, and is then most readily seen if only the bark is removed. But it may extend deep into the wood and then it can be seen very easily by cutting the stem transversely or longitudinally, as shown in

figure 5, whereupon the dark, discolored wood will contrast sharply with the white, healthy wood. The brown discoloration produced by a fungus should not be confused, however, with the general browning which occurs in the sapwood of a healthy elm soon after the bark has been removed and the wood has been exposed to the air.

The tendency of dead leaves to persist upon an elm in the fall for some time after normal leaf abscission has taken place is a late season symptom characteristic of diseased elms. These leaves may cling to the affected tree through most of the winter. Also, yellowing and shedding of leaves in the early and middle parts of the growing season indicates that a tree may be diseased. Such a condition need not, however, always be attributed to fungi, for it may be the result also of a lack of water or of an unbalanced nutritional condition of the soil.

Importance in nurseries.—Because of the general prevalence of the elm malady in Illinois nurseries, large losses have been incurred by nurserymen, especially in the northern part of the state. Since the “elm wilt” was first observed in one of the northern nurseries in 1925 it has spread widely, and during the past seven years thousands of young elms have been lost either because of the complete destruction of trees by disease or as a result of injury sufficient to render them commercially unsalable. Not only has there been direct economic loss; there has also been an indirect loss of time and money expended in planting and caring for trees which were killed by the disease after several seasons of care.

The elm malady is of state-wide distribution, and is most prevalent in the north. It is, however, more abundant in some nurseries than in others, and in a given nursery one block of elm stock may suffer to a greater extent than others. Since this investigation was begun many nurseries have been visited, and as yet no nursery has been encountered in which the elms are entirely free of disease.

It has been impossible to recommend to nurserymen or tree owners any dependable means for controlling or treating the elm malady. Not only was its cause unknown; it was even uncertain whether one disease or several existed. The general practice of nurseries in Illinois of following the instructions of the state's nursery inspector to cut out completely diseased trees which are obviously injured beyond saving and to prune out affected limbs when only slight disease is manifest has, however, resulted in a distinct protection to the purchaser of nursery elm stock.

Importance in cities.—Interest in this investigation has naturally centered upon the disease in nurseries, but it has not been entirely so restricted. Upon request, many elms grown for lawn or parkway

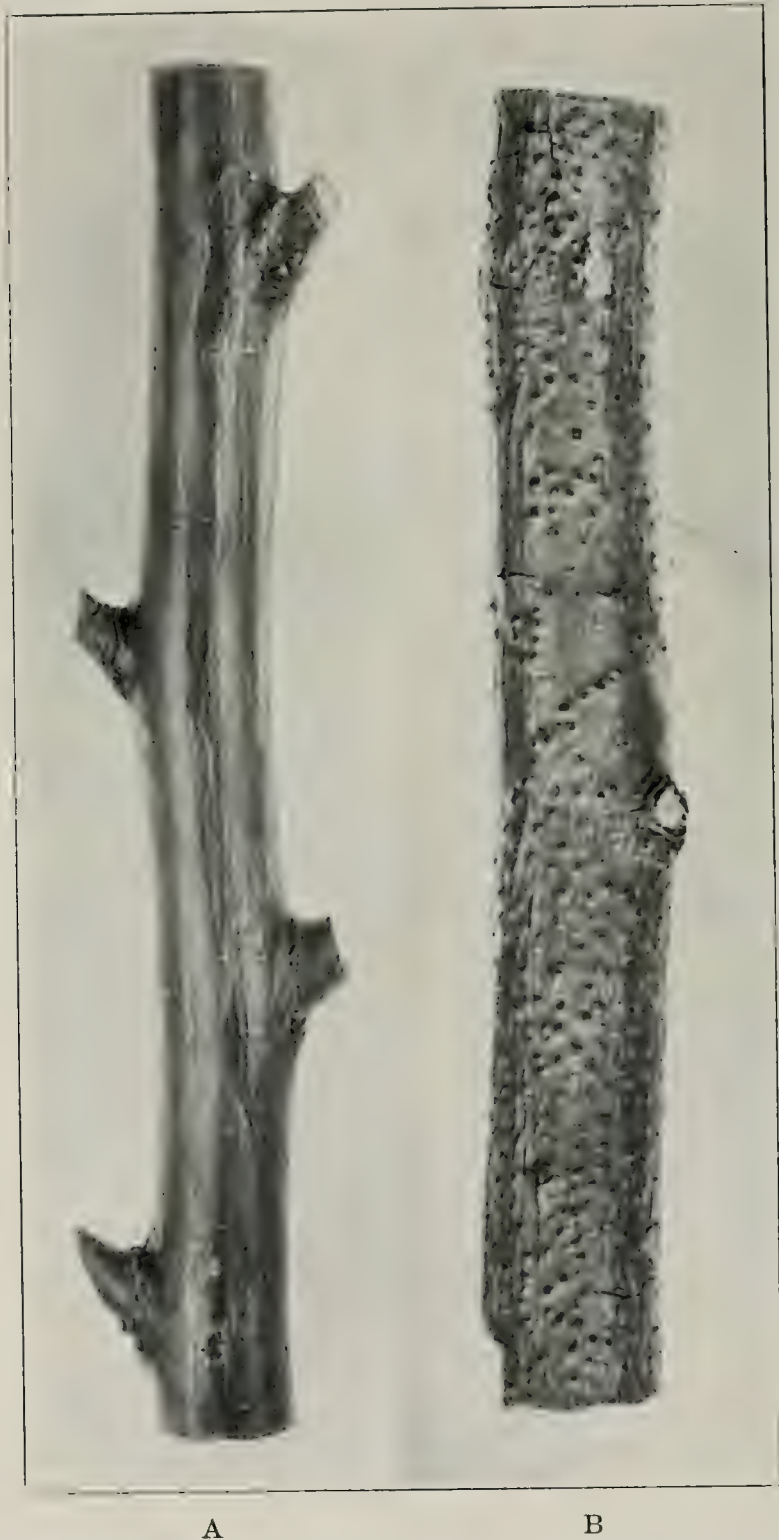
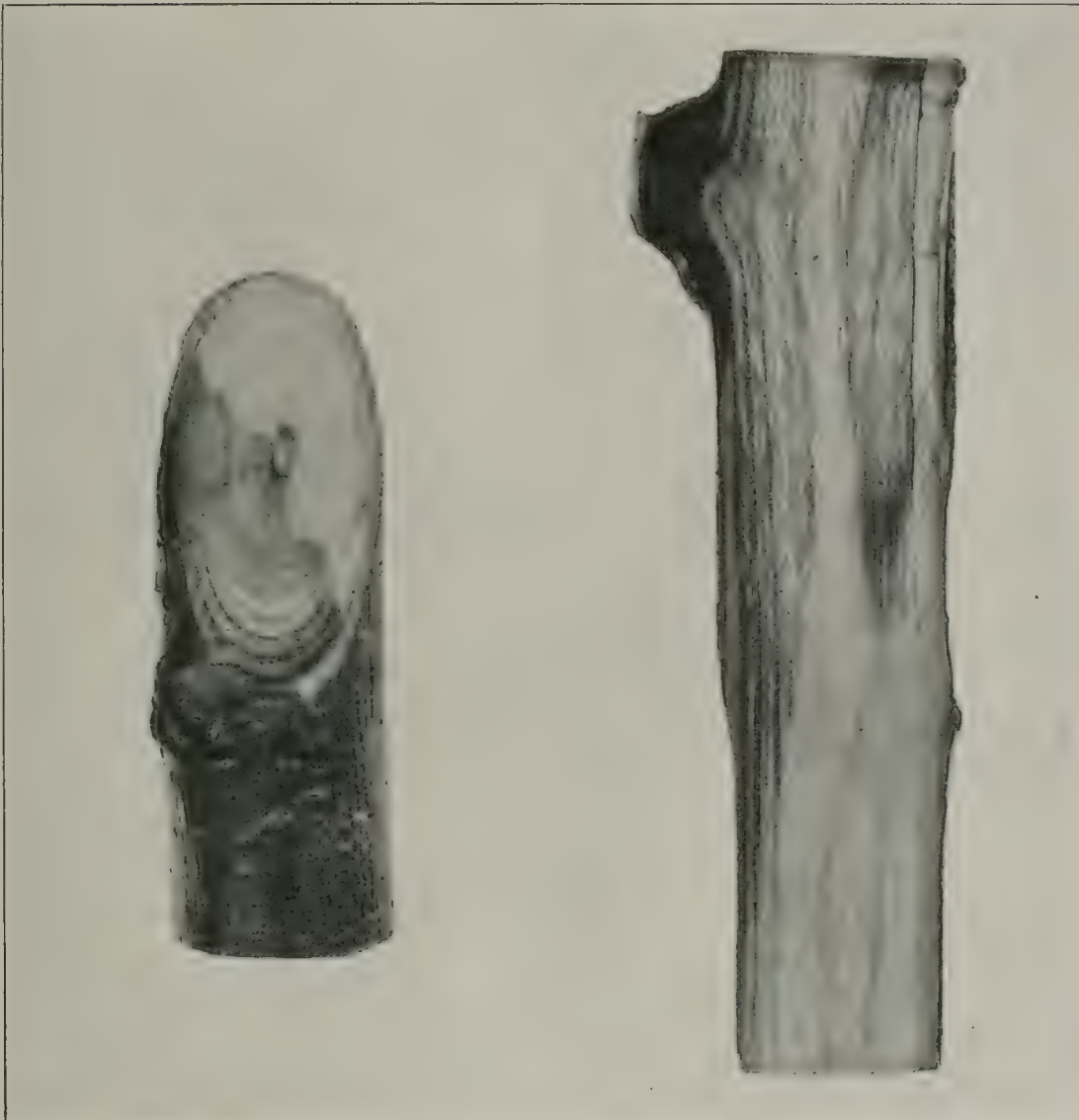


Fig. 4.—Cankers on elm branches. A.—The young canker, which extends along the upper side of the branch, is raised, thickened, and smoother than the healthy bark. B.—An old canker, through the dead bark of which an abundance of pycnidial pustules protrude. $\times 2$.

shading have been examined also, and the results of these examinations are included in this study.

In general, elms in parkways and lawns are not nearly so subject to disease as those in nurseries. This is probably due in part to the



A

B

Fig. 5.—Wood discoloration typical of the presence of disease. A.—An oblique cut showing that the discoloration lies beneath the canker and may extend to the heartwood. B.—A piece of branch split lengthwise shows the discoloration, above, in contrast with healthy wood, at the bottom. $\times 2$.

fact that these trees stand at some distance from each other, for infection apparently does not spread among them as readily as it does among crowded nursery trees. It has also been found that the fungi isolated from diseased trees in cities and towns are often quite different from those that attack trees in nurseries. This, however, is more fully explained in the subsequent discussion.

Some examinations have been made also of wild elms. These seem freer from disease than trees in city lawns and parkways. Usually they are in surroundings to which they are best adapted and seem, consequently, to be able to maintain a vigorous, healthy growth.

METHODS

THE initial objective of the investigation was to obtain as extensive an isolation of fungi associated with diseased elms as possible. This was a prerequisite for subsequent progress, because it is by studying the various organisms associated with a group of diseases that those actually causing disease are eventually selected.

Isolation of fungi from diseased wood.—In obtaining isolations of fungi from diseased trees several methods have been used. The usual procedure was to flame the outside of the twig after dipping it two or three times in 95 per cent alcohol. Next, thin slices were cut from the diseased portion of the stem with a sterile scalpel, and these, as soon as cut, were transferred with sterilized forceps to a dish of sterile water and rinsed thoroughly, usually in three changes of water. Then the wood slices were placed upon agar in Petri dishes, five or more to the plate as indicated in figure 6, and maintained at 23–26°C. As a rule fungi grew from the slices of wood into the agar after one to three days, but much longer periods were sometimes required, especially when high temperatures prevailed in the summer.

Another method used in some cases was to soak the slices of diseased wood in a 0.1 per cent solution of mercuric chloride immediately after they were cut. This treatment was found, however, to prevent or retard emergence of fungi from the wood, owing probably to the fact that elm being ring-porous the disinfectant penetrated too deeply into the large vessels to be rinsed out. This practice was finally discontinued, for sterilization of the surface or bark of twigs from diseased trees can be effected without the use of this disinfectant if care is used in flaming the outside surface of the stem. Rinsing the wood slices in sterile water may be omitted, also, since slices of dry wood will soon imbibe enough water from the agar to initiate growth of the fungus.

Culturing fungi from spores.—During the examination of specimens, particularly those bearing cankers, spore-producing fructifications of various fungi were often found. These were usually pycnidial structures, from which cultures were obtained either from single spores or by the spore dilution method.

In making spore dilutions, a single pycnidium was removed from a canker and placed in a drop of sterile water on a sterilized microscopical slide. Usually a cirrus of spores would exude from the ostiole of the pycnidium, though in some cases the pycnidium had to be crushed in order to release the spores. Then by means of a sterilized bacteriological loop, a loopful of the spore suspension was placed on an agar plate. Later, when growth had taken place, a transfer was made of a portion of the resultant growth.

The method used in making single-spore isolations has been outlined recently by Davis (1930), who states that it is similar to the method used by Rosenbaum (1912) for culturing *Thielavia* and by Anderson (1913) for culturing *Endothia*. It is essentially as follows.

A dilution of the spore sample is prepared in sterile distilled water so that when a loopful is removed it contains five to 20 spores. Several loopfuls of suspension are added to and mixed thoroughly in a tube of agar maintained slightly above the congealing point. Then the tube is emptied into a Petri dish and allowed to solidify. The spores, if large enough, can be located with the low power objective of a microscope and circled by a ring of India ink. After it is ascertained by careful focusing that no other spores are present in the ringed area at various depths of the agar, the encircled spore together with the surrounding agar is transferred to a separate agar plate for germination and development. In case the spores are hyaline and too small to be readily located, they may be allowed to attain an early stage of growth before being removed to separate plates.

The majority of our isolations of elm-inhabiting fungi were made upon "Difco" corn meal agar, though in some cases "Difco" potato dextrose agar was used. Most fungi produced their fructifications in greater abundance on the latter medium. Acidified agar was also used at times to inhibit the growth of bacterial colonies which, especially in the summer, developed in the plates. Acidification was accomplished by adding five drops of a 10 per cent solution of either acetic or lactic acid to a tube of agar. Stock cultures of all isolations have been maintained upon corn meal agar slants kept in a refrigerator at about 12°C.

Histological technique.—Some histological studies have been made in order to secure an explanation of certain phenomena associated with the elm malady but this phase of the investigation has been restricted intentionally as relatively unimportant at the present time. It will be necessary to determine more fully which fungi are parasitic and which saprophytic before an extensive histological study will be justified.

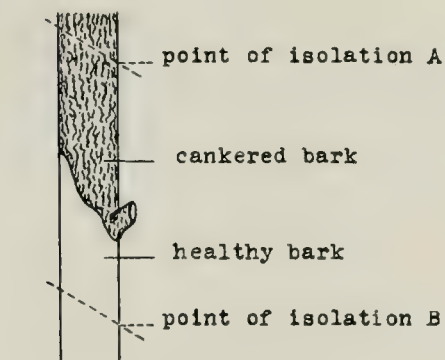
In order to section diseased branches, they were cut into pieces 2 to 3 inches long and softened by being kept in lacto-phenol 24 to 48 hours. They were then washed in water and transferred to a solution made up of 1 part of glycerine, 2 parts of 95 per cent alcohol and 3 parts of water, and kept in it for several weeks prior to sectioning. This treatment so softened the wood that satisfactory sections 7–10 μ thick could be obtained from stems 1 cm. in diameter. Very satisfactory differentiation between the fungus and the host tissue was secured with the Pianeze III-b stain described by Vaughan (1914).

Recording data.—For convenience and uniformity it has been found desirable to follow a definite plan in recording the data and notes pertaining to each specimen. An example of the method followed is reproduced in figure 6.

Specimen No. 9.

Date Collected: Sept. 27, 1931.
Place: Onarga Nursery,
 Onarga, Illinois.
Collected by: Tehon and Harris.
Isolation attempted: Oct. 2, 1931.

Description: Specimen taken from tree No. 18 of Row No. 17. Tree 4½ ft. high and with canker on one side of main terminal or leader. Specimen cut off 1 ft. below outside canker. Brown wood discoloration beneath canker and also the bark below canker.



Specimen No. 9.

Method: Stem flamed 3 times in 95% alcohol, cut at the points indicated in the diagram and small sections cut therefrom with flamed scalpel. Sections placed in .1% HgCl₂ for 3 minutes and then washed thoroughly 3 times in sterile water. Transferred with flamed forceps to poured plate of Difco corn-meal agar as indicated in the plate diagrams below.

Isolation 9A-5.
 Appeared Oct. 8, 1930.
 Transferred Oct. 11, 1930.
 Determined as Coniothyrium
 Feb. 2, 1931.

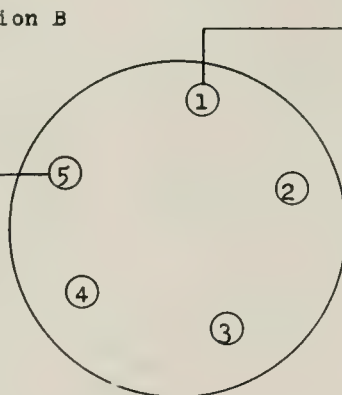


Plate No. 9 A.

Isolation 9A-1.
 Appeared Oct. 8, 1930.
 Transferred Oct. 11, 1930.
 Determined as Coniothyrium
 Sept. 30, 1931.

Isolation 9B-1.
 Appeared Oct. 8, 1930.
 Transferred Oct. 11, 1930.
 Determined as Coniothyrium
 Sept. 30, 1931.

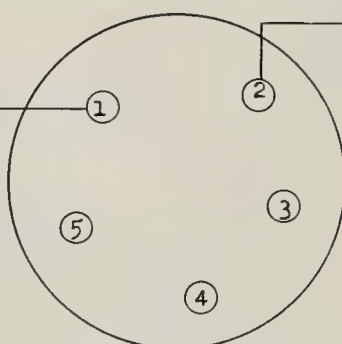


Plate No. 9B.

Isolation 9B-2.
 Appeared Oct. 8, 1930.
 Transferred Oct. 11, 1930.
 Determined as Coniothyrium
 Oct. 15, 1930.

Fig. 6.—Form used in recording data concerning isolation tests of material from diseased elms.

The specimens are numbered consecutively in the order of their collection, and the number of each placed in the upper left corner of the

sheet. In the upper right corner the date, place, collector and the date an attempt was made to isolate a parasite are recorded. Next follows a brief description of the symptoms manifested by the diseased tree and also by the particular specimen taken from the tree. The diagram at the left shows the piece of diseased stem from which isolation trials were made, and the points from which slices were taken for plating are marked.

Description of the method used in making isolations from the stem stands at the right of the diagram of the stem, while the lower half of the page contains diagrams of the plates and of the wood slices planted on them. Each plate is numbered to correspond to the specimen from which it was made, various plantings of the same material being designated as A, B, C, etc., and the wood slices in each plate are numbered consecutively. Each fungus isolated receives its number from the plate and the wood slice from which it grew. Thus, an isolation from plate 9A and wood slice 5 is designated 9A-5. The date on which the fungus first appeared, the date of its transfer to stock culture and its determination are also recorded on this sheet, as well as the final disposition of the plate.

When a fungus grew from a wood slice a transfer from it was made to a stock slant of corn meal agar. Subcultures on plates were made subsequently from the stock for further study of the fungus, especially if fructifications were not formed by the original isolation. Data pertaining to the later development of each isolation were recorded on separate sheets, one for each isolation, and additional sheets were inserted when necessary.

GENERAL RESULTS OF CULTURAL TESTS

As previously stated, the preliminary work in this investigation has been concerned chiefly with determining what fungi are associated with the elm malady. In order to accomplish this, specimens from diseased elms have been collected from as many parts of the state as possible, and numerous specimens have been received from nurseries, nursery inspectors and laymen. This has greatly increased the extent to which the diseases prevalent in different localities could be determined.

Shortly after the isolation of fungi from diseased material was begun, it became quite evident that the elm malady in Illinois was not a single disease caused by one organism but was, rather, a number of diseases caused in all probability by an equal number of different organisms. At this writing, approximately 200 specimens have been examined or cultured and from them 512 isolations of fungi have been made. Among these isolations 20 genera of fungi are now recognized and there are, besides, 101 isolations, or about 20 per cent, which have as

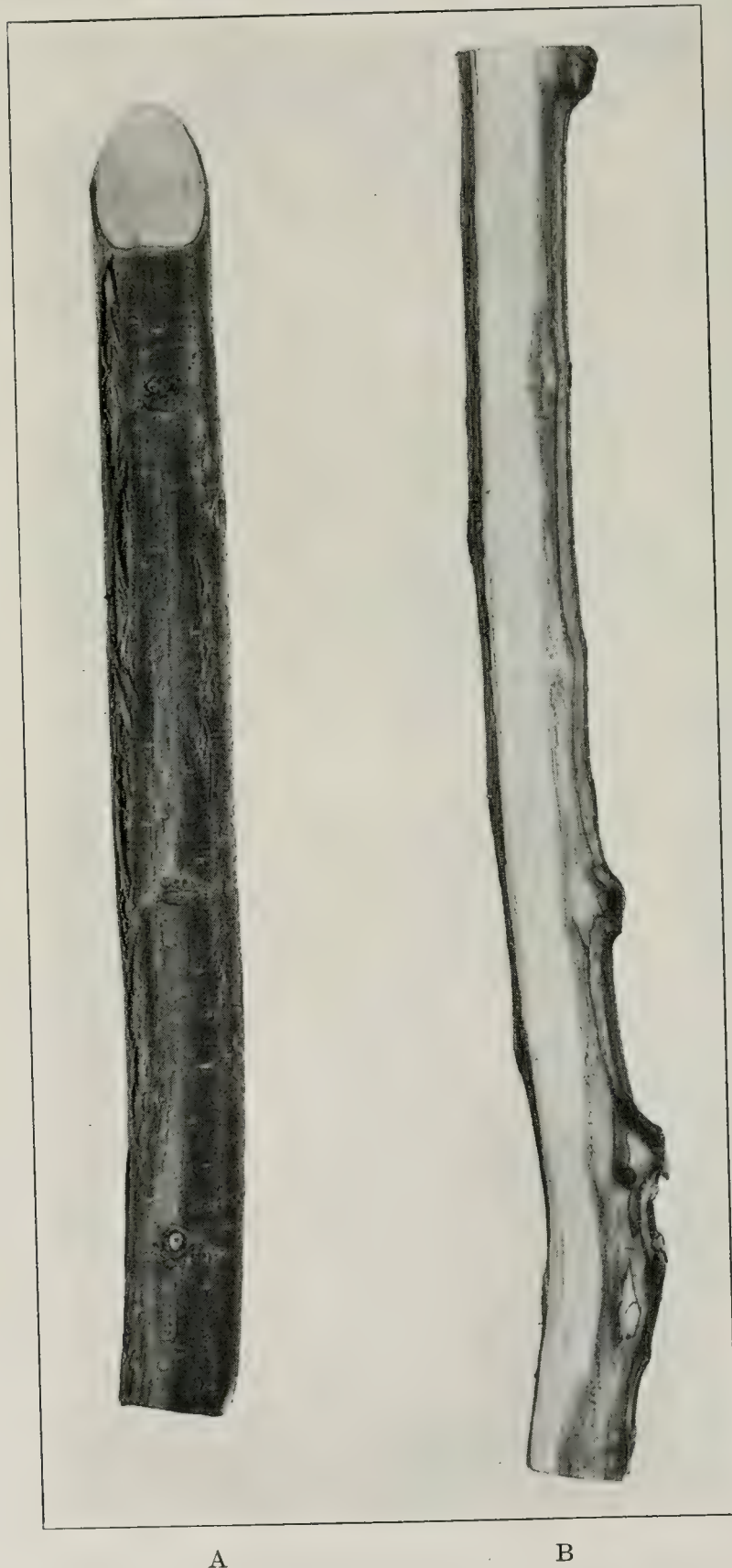


Fig. 7.—Canker characteristic of the *Coniothyrium* disease. A.—Outwardly, the cankered side of the branch is flattened and the bark has cracked along its margin. Numerous pycnidia of the fungus are present in the cankered area but are so small as to be quite readily overlooked. B.—Inside the branch, the wood shows a very definite, continuous, diffused discoloration along the cankered side. $\times 1$.

yet not been induced to fruit in our cultures. Consequently, the number of genera and species of fungi ultimately to be represented in this collection will undoubtedly be increased considerably. In several instances different species of fungi belonging to the same genus have been isolated, so that nearly 30 distinct species are now recognized.

The results of the isolations of fungi from diseased elms have been compiled in table I to show the number of times each organism has been isolated and also its per cent of occurrence among the total number of isolations.

In addition to the fungi listed in table I three genera, *Cytospora*,² *Diplodia* and *Phomopsis*, have been derived from diseased elms by

TABLE I.—FUNGI ISOLATED FROM DISEASED ELMS BETWEEN SEPTEMBER 30, 1930, AND DECEMBER 31, 1931, ARRANGED IN THEIR ORDER OF FREQUENCY.

Fungus genus	Number of times isolated	Per cent of total isolations
<i>Alternaria</i>	120	23.44
<i>Coniothyrium</i>	83	16.21
<i>Bacteria</i>	43	8.40
<i>Phoma</i>	19	3.71
<i>Cephalosporium</i>	14	2.73
<i>Sphaeropsis</i>	11	2.15
<i>Fusarium</i>	10	1.95
<i>Stemphylium</i>	7	1.36
<i>Vermicularia</i>	7	1.36
<i>Nigrospora</i>	3	.59
<i>Anthostomella</i>	2	.39
<i>Helminthosporium</i>	2	.39
<i>Epicoccum</i>	1	.20
<i>Rhabdospora</i>	1	.20
<i>Verticillium</i>	1	.20
<i>Xylaria</i>	1	.20
Non-fruiting.....	101	19.73
Negative.....	72	14.06
Contaminations.....	14	2.73
Totals.....	512	100.00

single-spore isolations, the pycnidia and spores having been encountered during microscopical examination of diseased specimens.

From the data given in table I it is readily seen that almost one fourth of the cultural isolations are *Alternarias*. However, this fungus

² Since completion of this report, *Cytospora* has been obtained also by direct culture from diseased wood.

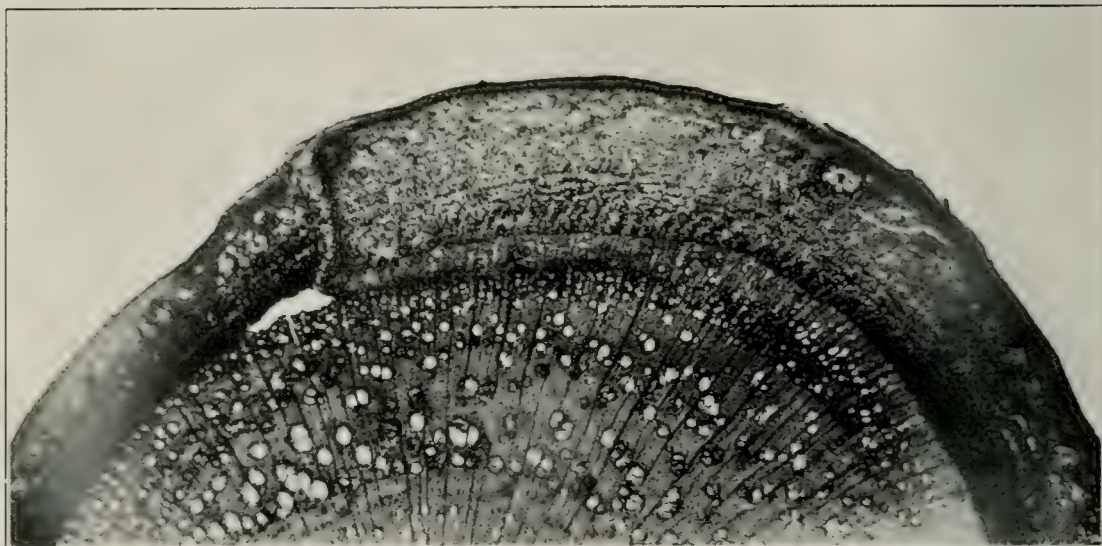


Fig. 8.—Effect of the *Coniothyrium* disease upon growth, as shown by a microscopic cross section, $\times 25$. To the left is the canker, separated by a callus tissue from the healthy part. The tissues in the cankered region are dead, but the healthy side of the stem has continued to form new wood and cortex. Notice how the tissues have been torn apart where the diseased and healthy regions join.

and *Stemphylium*, so far as the investigation reveals, are chance inhabitants of the bark and do not produce any serious or destructive disease. *Coniothyrium*, which constitutes 16 per cent of the isolations, is the one outstanding fungus responsible for serious disease. Bacteria, which as a group occur to the extent of 8 per cent and rank next highest, are of doubtful importance. In some instances they may have been obtained in culture because of incomplete surface sterilization of the sections. Many times, too, they failed to grow from one or more of the wood slices in a given plate.

Of the remaining fungi, those which appear to be more or less important as causes of disease are *Phoma*, *Sphaeropsis*, *Vermicularia* and *Verticillium*. The pathogenicity of *Sphaeropsis* (Hubert, 1931, and Hubert and Humphrey, 1920) and *Verticillium* (Meer, 1926) has already been demonstrated by previous investigators; but since they have occurred in our cultures much less frequently than *Coniothyrium* they must be considered less important in Illinois than they are thought to be elsewhere, though their attack upon a single elm is, it is true, very serious. The other fungi listed in the table have been obtained but very few times in our isolations and must therefore be considered of minor importance, even though their rôle as parasites may be established later. Nearly 14 per cent of the attempted isolations remained sterile and only a very small number, less than 3 per cent, became contaminated to the extent that growths emanating from wood slices could not be used reliably.

In platings such as we have made, it frequently happens that the same original material, when tested, yields several different fungi. To date, 32 culture plates have yielded more than one fungus, and 13 different combinations of twos or threes have occurred. These combinations and the number of times each has occurred are shown in table II.

TABLE II.—COMBINATIONS OF FUNGI OBTAINED IN AGAR PLATE ISOLATIONS FROM DISEASED ELMS.

Combinations	Number of occurrences
Coniothyrium—Alternaria.....	19
Coniothyrium—Phoma.....	2
Coniothyrium—Fusarium.....	1
Coniothyrium—Rhabdospora.....	1
Coniothyrium—Vermicularia.....	1
Coniothyrium—Vermicularia—Nigrospora.....	1
Phoma—Alternaria.....	1
Phoma—Cephalosporium—Alternaria.....	1
Nigrospora—Alternaria.....	1
Epicoccum—Alternaria.....	1
Stemphylium—Alternaria.....	1
Cephalosporium—Alternaria.....	1
Cephalosporium—Anthostomella—Nigrospora.....	1
Total.....	32

Some of the fungi in these combinations are undoubtedly saprophytic and grow from the plated wood slices at the same time as the parasitic fungi, but until inoculation tests have definitely determined which are pathogenic a fully satisfactory explanation of all these combinations cannot be made. However, from the study that has been made of some of the fungi the relationship existing in at least some of these combinations appears fairly certain. In the *Coniothyrium-Alternaria* and *Phoma-Alternaria* combinations, *Alternaria* seems to be a secondary invader with only a saprophytic role. It probably has the same relation in other combinations. It is conceivable that an elm may become infected by more than one parasitic fungus at points not greatly remote from each other. Later these fungi may so spread within the tree as to penetrate the same tissue and when platings are made they are, of course, secured in culture. In the *Coniothyrium-Phoma* and *Coniothyrium-Vermicularia* combinations, both fungi in each of the combinations were apparently parasitizing the same tree. Also, after

a tree or branch has been killed by a parasitic fungus almost any number of secondary saprophytes may invade the affected parts. As the parasite penetrates further into the living parts of the tree, the dead limbs are left to the saprophytes. This seems to have occurred in specimens from which only the *Epicoccum-Alternaria* and *Stemphylium-Alternaria* combinations were derived. The other combinations are of doubtful significance and must remain so until results from inoculation tests are completed.

SPECIFIC DISEASES

THE malady now attacking elms in Illinois has been quite generally and popularly termed "elm wilt," especially by nurserymen, though it certainly is not a true wilt according to the pathological definition of the term. In popular usage the term probably refers to any condition in which withering and dying of foliage on the affected parts is conspicuous. In order to eliminate any possible misunderstanding as to the nature of elm diseases in Illinois, the term "wilt" should be restricted in application and in reference to those diseases which are true wilts in accordance with the technical interpretation.

The various elm diseases in Illinois manifest themselves, as has been stated, in a number of ways, chief of which are the production of cankers, twig blights, diebacks and true wilts. Examples of fungi causing cankers are *Coniothyrium*, *Phoma*, *Sphaeropsis* and *Phomopsis*. Pustules containing the pycnidia and spores of *Diplodia* and *Cytospora* have also been found to occur in cankers. In addition two fungi, *Coniothyrium* and *Sphaeropsis*, also produce a blighting of the young twigs, and the latter is credited with causing a dieback. *Verticillium* and *Fusarium*, which cause true wilt diseases in many kinds of plants, have also been obtained from diseased elms. This investigation has been chiefly concerned with the fungi attacking the stems and branches of elms, though it has also been observed that leaf spots due to *Gleosporium* and *Gnomonia* are of common occurrence on elms in the nurseries, just as they are on trees in cities. These leaf spots, which have already been investigated by Miles (1921), are unimportant except in unusual seasons, when they cause severe defoliation. Their economic importance lies in the fact that, in severe cases, they may weaken the tree.

TRACHEOMYCOSIS ASSOCIATED WITH CONIOTHYRIUM SPP.

As indicated in table I, the fungus thus far classified as *Coniothyrium*³ is the most important fungus involved in the elm malady. Other

³ The tracheomycosis of elms most commonly found in nursery trees yields a fungus for which we are provisionally using the generic name *Coniothyrium*. The histologic aspects of the disease are, however, so unusual for *Coniothyrium*, and certain points of morphology in the fungus are so puzzling, that further study of the fungus is desirable before more definite identification is made.

fungi may be equally as severe in their attack upon individual elms, but the fact that they are of less frequent occurrence and not nearly so widely distributed necessitates ranking them as less important than *Coniothyrium*. From the material thus far examined it is quite apparent that the *Coniothyrium* disease is widely distributed throughout Illinois. It has been collected at Mounds City in the extreme southern portion of the state, and as far north as Libertyville, in Lake county. In western Illinois it has been found at El Dara, and in the eastern part at Danville. It is apparently most prevalent, however, in the east-central and north-eastern parts of the state.

The *Coniothyrium* disease causes the death of an elm by spreading through the tree year after year. It has, however, been observed in some cases to produce only a twig blight involving either only a few or a considerable number of twigs. An elm very severely infected and damaged by the *Coniothyrium* disease is shown in figure 2. Blighting of small twigs is apparent in all parts of the tree but it is most evident and most abundant in the top. This blighting of small twigs by *Coniothyrium* further substantiates the conclusion, previously set forth (p. 6), that the disease gains entrance into the tree through the young and actively growing shoots at the tips of branches. From observations made of the twig blight stage of *Coniothyrium* infection, its apparent effect is not that of killing the tree at once but that of producing a general unthrifty condition. In addition to the characteristically dead and blighted twigs, infected trees produce not only fewer leaves than do normal trees but leaves which are both smaller and so widely scattered that they never form a very thick foliage. In the case of young seedling trees it has been noticed that although the terminal shoot becomes infected and blighted at the tip, for some reason the disease is sometimes incapable of making further prog-



Fig. 9.—Elm stem cut obliquely to show the wood discoloration typical of the *Coniothyrium* disease. The discoloration occurs chiefly beneath the canker but is diffused deeply in the stem. In the current season's wood, however, it has formed a distinct though discontinuous circle. $\times 2\frac{1}{2}$.



Fig. 10.—A young nursery elm dying from *Coniothyrium* infection. This tree shows the ultimate effect of the disease. The entire right half is dead and a severe blighting of twigs has taken place in the left side. The infection, which evidently first entered through the old leader, finally reached the base of the tree. Photographed October 17, 1931.

ress. Save for these dead tips, such trees make a healthy growth, since the disease has not extended downward from the dead tip into the tree. It is more common, however, for *Coniothyrium* ultimately to bring about death of the infected tree within two or three years.

The injury which may be done to a nursery tree by continued extension of the *Coniothyrium* disease is very well shown in figure 10. The leader, or main shoot, of the tree shown in the picture had been pruned off the previous year in order to prevent, if possible, the downward progress of the disease. This treatment was ineffective, however, since the internal infection had already progressed some distance beyond the point of pruning. Consequently the infection continued to grow through the tissues of the tree and infected the new leader and several of the lateral branches. The result has been destruction, practically, of the tree. Infection has progressed beyond any hope of stopping it, as discoloration of the wood was found to extend to the base of the tree.

The first manifestation of the disease, as it has been observed most often in the nursery, is dying of the tips of young shoots or small twigs. This usually occurs toward the top of the tree, but twigs and shoots arising from the lower laterals and the trunk may also be involved.

It has been impossible as yet to determine either the exact means by which the fungus gains entrance or the point at which infection starts. Careful examination of many examples indicates, however, that infection occurs early in the growing season, probably just as or shortly after the tree begins to leaf out, and that the fungus gains entrance either through the growing shoots or the unfolding terminal or axillary buds. After infection has taken place those leaves nearest the point of infection turn yellow and then gradually become light brown. Finally, when the tissue is dead, the leaf becomes dark brown, dry and brittle. This yellowing and browning does not necessarily occur at once over the entire leaf. A portion of the leaf may still be green while other parts are becoming yellow or brown, and all intermediate stages of dying tissue may be found simultaneously. The disease, however, is not in the leaf, but in the twig, and the dying of the leaves, which apparently is due to the water supply being cut off, is merely a symptom of the presence of infection in the twigs.

As the disease progresses downward through the shoot, additional leaves are killed and the diseased shoot curls at the tip in the manner illustrated in figure 3. Most of the foliage falls, though terminal leaves persist for a long time. If infection takes place later in the year, the dead leaves usually do not fall very readily but have a tendency to persist and may remain attached to affected trees for a considerable period

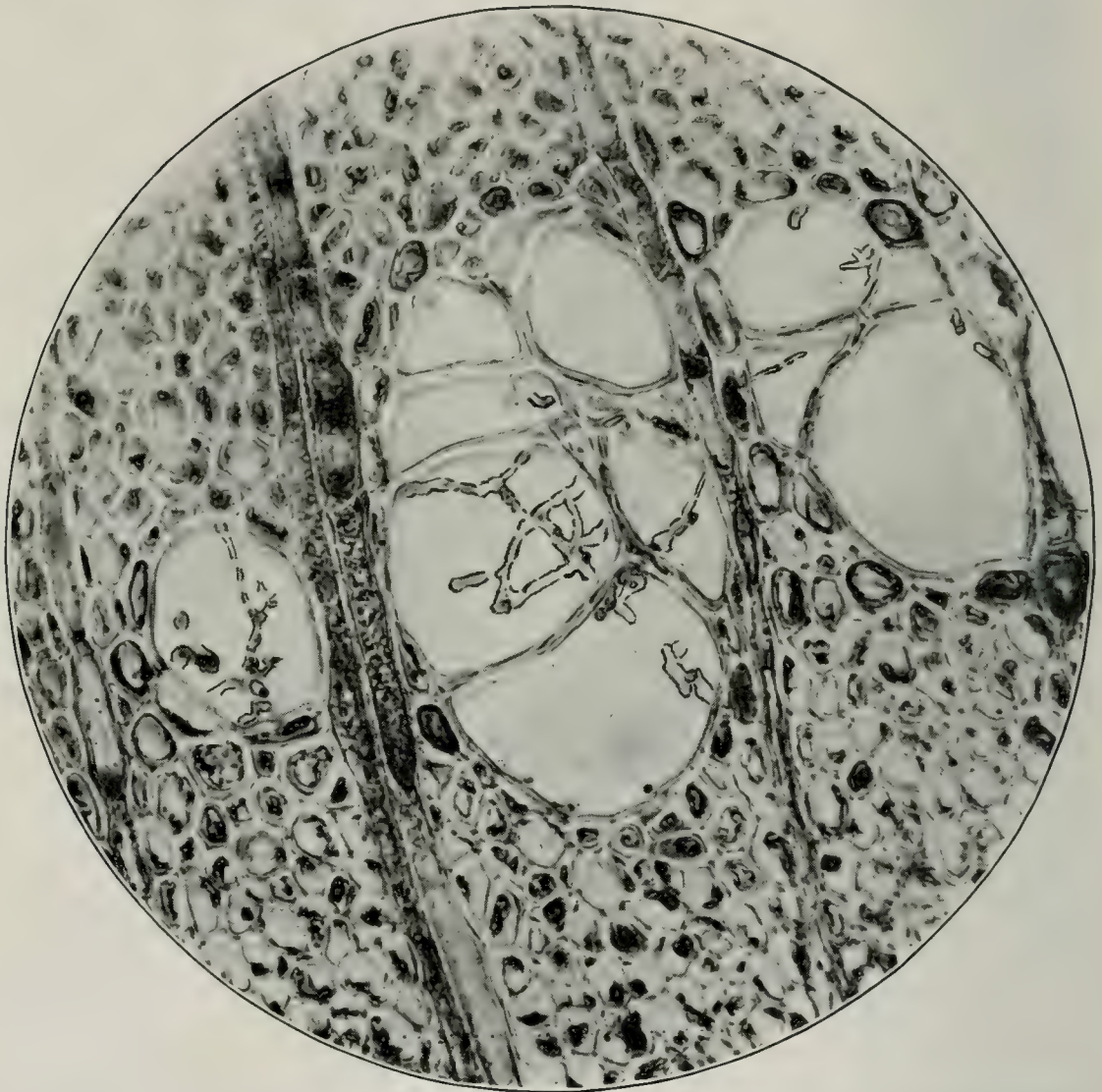


Fig. 11.—Photomicrographic cross section, $\times 450$, of diseased elm wood, showing the *Coniothyrium* fungus in the water ducts and in the surrounding wood fiber cells.

after normal leaf fall, due to the fact that a normal abscission layer was not formed. The characteristic shepherd's-crook curling of the tips of the shoots and the persistent dead leaves furnish a ready and certain means of locating diseased trees in nursery rows. These are not distinctive characteristics, however, which will adequately differentiate the *Coniothyrium* disease from other diseases, since there are other elm diseases for which the persistency of dead leaves and crooking of diseased branches at the tip has been described.

As already stated, the *Coniothyrium* disease appears to begin in the top shoots of the tree. From these it progresses downward into the lateral branches or twigs. When the original infection seems to have occurred elsewhere than through the terminal shoots the disease may extend both up and down the branch from the infected twig. Small cankerous areas appear on the outside of infected branches. These

are sunken, water soaked, and vary in color from reddish to greyish brown. They may extend entirely around young shoots and twigs, but on larger and older branches they show on only one side, as in figure 7A. Large lesions are usually dark purple and are more or less water soaked. The branch is decidedly flattened on the cankered side, and the outer bark often splits or cracks at the edge of the lesion.

Flattening of the branch at the cankers results from the fungus killing the cambium on the diseased side, after which growth ceases there. The cambium in the healthy portion of the stem continues, however, to form new wood. Lateral branchlets and twigs arising from the flattened, cankered side of a branch are almost invariably dead, while those arising along the healthy side continue to live until the fungus kills the entire branch.

The internal changes which occur when a stem is invaded by *Coniothyrium* are shown in figure 8, somewhat to the left of the center of the section. In the tissues peripheral to the xylem a radial callus has been formed between the cankered, diseased portion of the stem and the healthy part, the purpose of which is evidently to prevent spread of the fungus laterally. In the left third of the picture the cambium has been invaded and killed by the fungus, and no development has occurred. At the right, however, the cambium, protected by the callus between it and the dead portion, has continued to live and to produce a thick cortex. The increase of cortical tissue in the healthy region contrasts decidedly with the lack of development in the diseased part. A further difference between the diseased and healthy sides of the stem shown in figure 8 is that a considerable amount of xylem or woody tissue has been produced on the healthy side since the occurrence of infection, while none has been formed in the cankered area. Where the cambium was not killed by the fungus it formed additional new layers of both xylem and phloem, resulting in an increase in stem diameter on that side, but where it was killed no new xylem or phloem could be formed and the canker remained flat and apparently sunken.

As a result of growth in the healthy regions the outer tissues were torn loose from the wood where the canker and healthy part joined, leaving an irregular cavity in the canker adjacent to the callus tissue. Subsequent growth brings about the cracking of the outer bark illustrated in figure 7A.

In addition to the outward symptoms exhibited by the *Coniothyrium* disease, a very marked discoloration of the wood of the stem occurs. It varies from light to dark brown, according to the stage of development of the disease. A transverse cut of an infected branch, such as that shown in figure 9, shows the discoloration to be more or

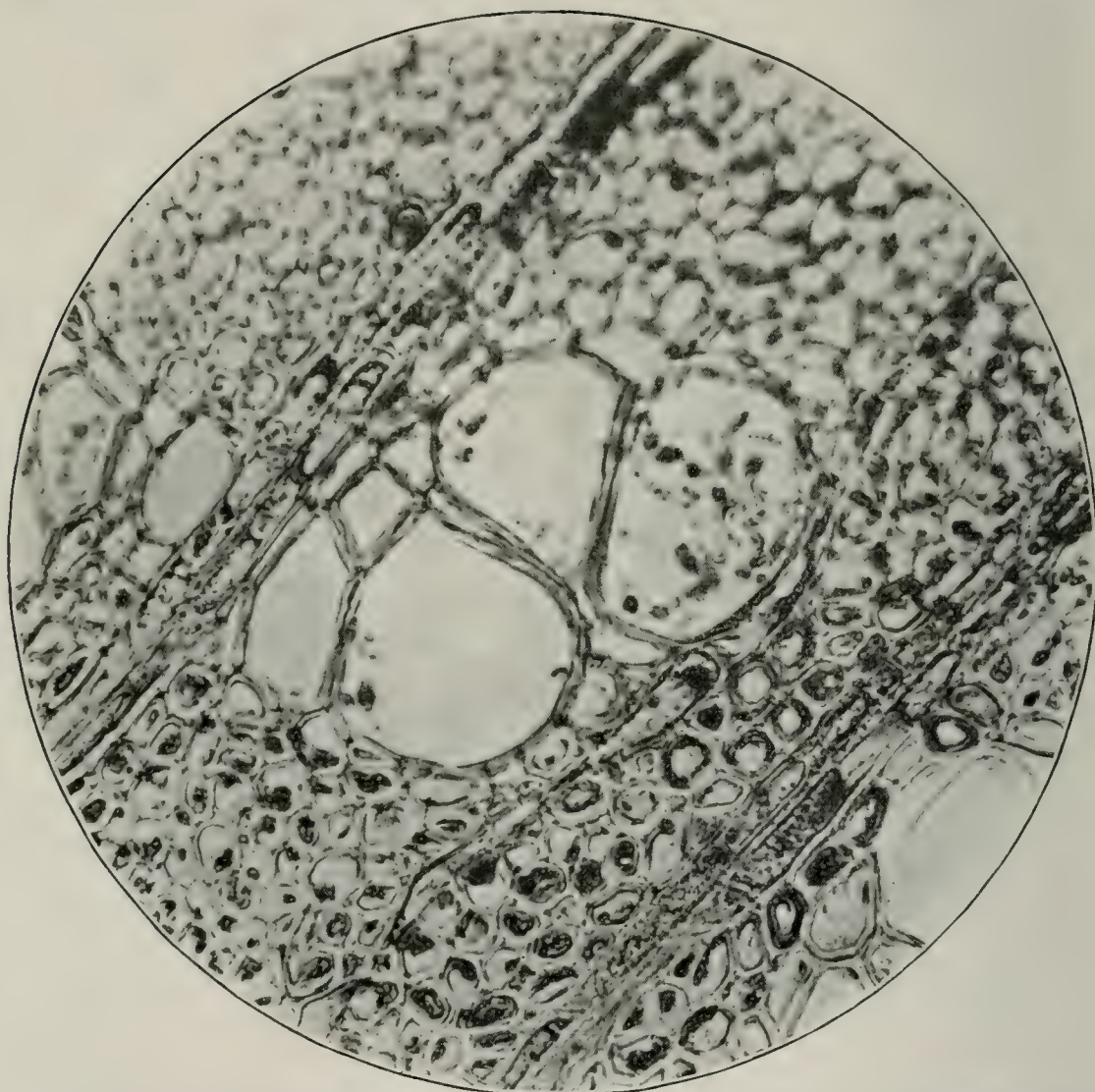


Fig. 12.—Photomicrographic cross section, $\times 450$, of *Coniothyrium*-infected elm wood, in which a large water duct is nearly plugged by the massed hyphae of the fungus.

less diffused and to be present chiefly in the cankered side of the stem. In the wood last formed the discoloration is darker and heavier. Very often the discoloration in the sapwood may form an almost continuous circle in the stem, but just as often the discoloration may appear in small scattered areas. The smaller discolored areas are not, however, sharply outlined in the stem but merge gradually into healthy wood.

If a branch be cut lengthwise, as shown in figure 7B, the wood discoloration will be found to extend mainly along one side of the stem, directly beneath the sunken and flattened canker. The discoloration is so evenly diffused that it forms a continuous brown stripe. In relatively new infections the discoloration may be light, but in older and more severe infections it is dark brown.

The minute, black pycnidial fructifications of the fungus are produced only after the diseased parts die. They have been found near the

tips of small dead twigs and in cankered areas on larger stems. In the latter case the bark becomes shrunk and loose, and tends to split and peel from the cankers in thin layers or strips. Often the pycnidia, though not visible externally, can be found when the loose bark is removed. Abundant pycnidial formation has also been found to occur upon wood surfaces left exposed as a result of pruning. This, of course, happens only when an infection is not removed completely and diseased wood has been left below the pruning point. The small stub left as a result of the pruning dies, and pycnidia develop on the exposed end of it.

A histological study of a diseased stem shows that the fungus first invades the cortex and the phloem and brings about a great disjunction and disorganization of the cells composing those tissues. Frequently the phloem is so severely attacked that it is almost completely destroyed. In both cortex and phloem the mycelium is both intercellular and intracellular. The cambium is killed next, and after that the fungus advances into the adjacent xylem, or sapwood, though apparently with more difficulty. In the early stages of its progress it is largely confined to the medullary rays, but from these it eventually extends into the xylem cells. In going from the medullary rays into the xylar elements and from one xylar cell to another the fungous hyphae are capable of direct penetration of the walls, though they frequently accomplish the penetration of a new cell by means of the pits in the walls of tracheae and other cells. The fungus extends quite generally throughout the xylem in all directions, but, as shown in figure 11, it is most easily seen in the large water conducting cells and produces there a typical tracheomycosis. It is, however, also abundant in the other xylar cells. In many cases the hyphae are so abundant in the tracheae and xylar elements that they almost fill the cells, as can be seen in one of the large tracheal vessels in figure 12. The only apparent limitation of the mycelium suggested in figures 11 and 12 to a few isolated or scattered tracheae indicates that the tracheae are utilized as an important avenue of progress in the extension of infection up and down the stem.

The extent to which the mycelium of *Coniothyrium* is distributed in diseased wood is illustrated better in longitudinal than in cross sections. Figure 13 shows a thin longitudinal section of diseased wood magnified 100 diameters. The clear spaces running horizontally through the picture are water ducts, and the fine beadlike strands in them are threads of the *Coniothyrium* fungus. At some points the water ducts are almost plugged by dense aggregations of such threads. A more detailed view of the fungus in the water ducts is shown at a magnification of 450 diameters in figure 14, and there it can be seen how the fungous threads pass from one duct to another and even into

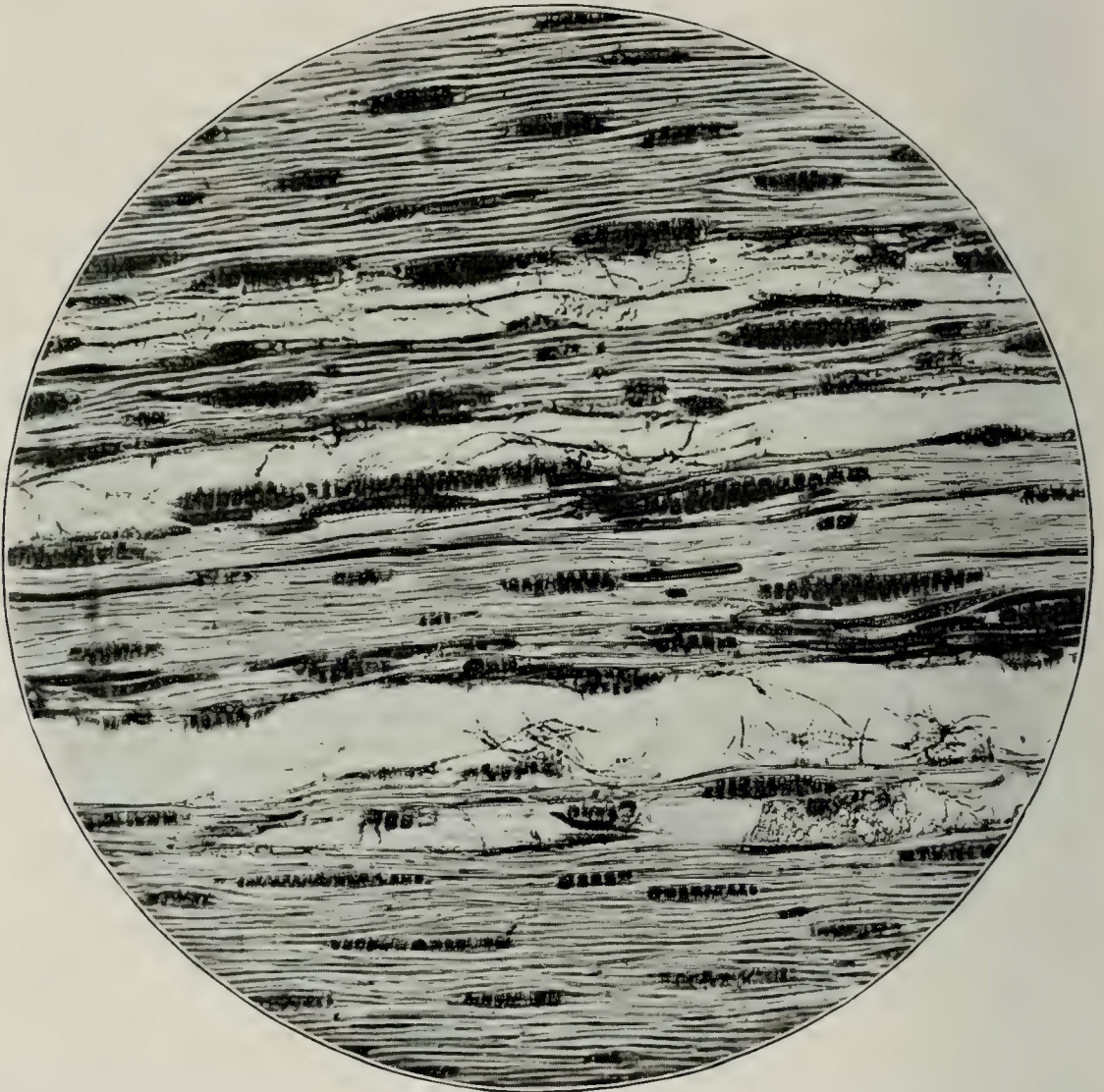


Fig. 13.—Longitudinal tangential section of diseased elm wood, $\times 100$, showing the mycelial threads of *Coniothyrium* in the water ducts. The fungus evidently uses these unobstructed ducts as channels through which to proceed from the point of infection to other parts of the tree.

the dense, woody structure of the branch.

The fungous threads which traverse the water ducts are generally of large diameter, possessed of thick walls, and filled with densely granular protoplasm. From these ducts fine branches penetrate, by way of pits in the vessel walls and by dissolved passageways, into the wood fiber cells; and in the cavities of these cells the threads are smaller in diameter. A single thread, with its multitude of branches, can be traced for long distances through the wood. The manner in which the mycelium penetrates throughout the wood fibers is shown in figure 15, which shows a portion of a longitudinal section at a magnification of 300 diameters.

The pathological condition known as gummosis, which is often an accompanying microscopical symptom of fungous infection of living



Fig. 14.—Longitudinal tangential section of diseased elm wood, $\times 450$, showing appearance of the mycelial threads of *Coniothyrium* in the large water ducts. Presence of the fungus stops the transportation of water, and those parts of the tree above the infection die from lack of water.

woody tissue, occurs commonly in connection with the *Coniothyrium* disease, as is shown in figure 16. The lumen of many of the xylar elements, especially the large tracheae, becomes completely filled with brownish granular gum. Walls of the cells that are filled with these deposits are usually much enlarged and swollen and appear to be undergoing dissolution. That these gummy deposits in the xylem are not normal resinous deposits such as occur in the nonfunctional heartwood of trees is evident from the fact that they are present even in the sapwood of very young stems. Examination of sections from a healthy elm twig has shown, too, that this gummosis does not exist in healthy xylem, though, as stated before, is of very common occur-



Fig. 15.—Direct reproduction at 300 diameters of a longitudinal section of diseased elm wood, showing how the *Coniothyrium* mycelium ramifies and penetrates throughout the woody structure.

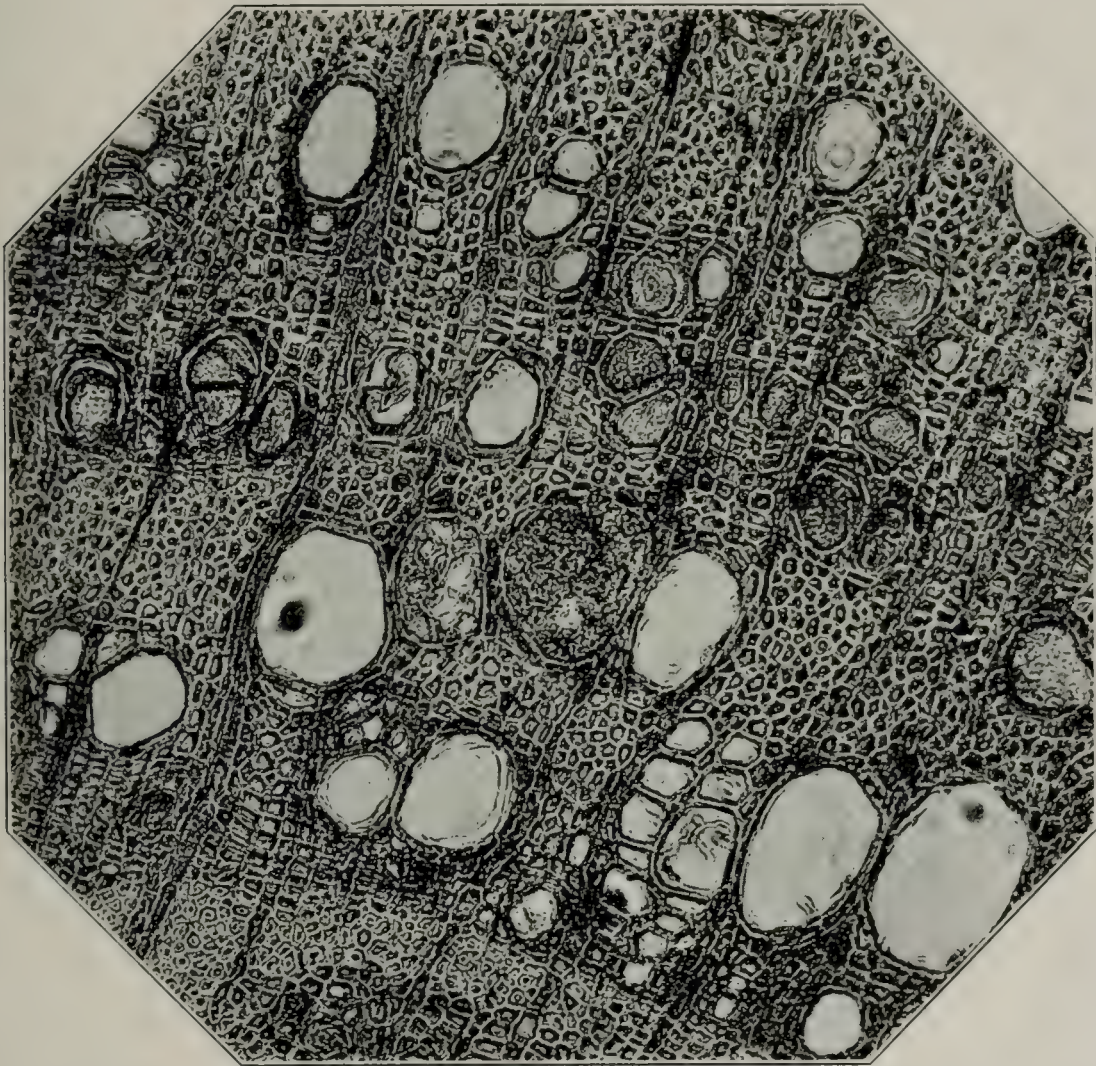


Fig. 16.—Cross section of diseased elm wood, $\times 450$, showing the effect of *Coniothyrium* infection upon the wood tissues. The mycelium of the fungus appears in some of the large water ducts, but other cells of the same kind are filled with dense deposits of gum. The walls of the gum-filled cells are indistinct and evidently partly disintegrated. (See text, p. 28).

rence in the wood of diseased stems.

In isolations made from material of the *Coniothyrium* disease two kinds of *Coniothyrium* have been obtained. Neither of these *Coniothyria* have as yet been definitely identified. They are, however, quite readily distinguishable from each other, both in morphology and in cultural characteristics. For convenience of treatment here they will be referred to as *Coniothyrium A* and *Coniothyrium B*.

The kind designated as *Coniothyrium A* is of more common occurrence and has much larger spores than the other. Its pycnidia, which range from 95 to 350 μ when formed on elm stems, are membranous, spherical to subglobose, and appear black and opaque until the spores are released, when they become light or dark translucent brown. A light colored stroma often surrounds the walls of pycnidia

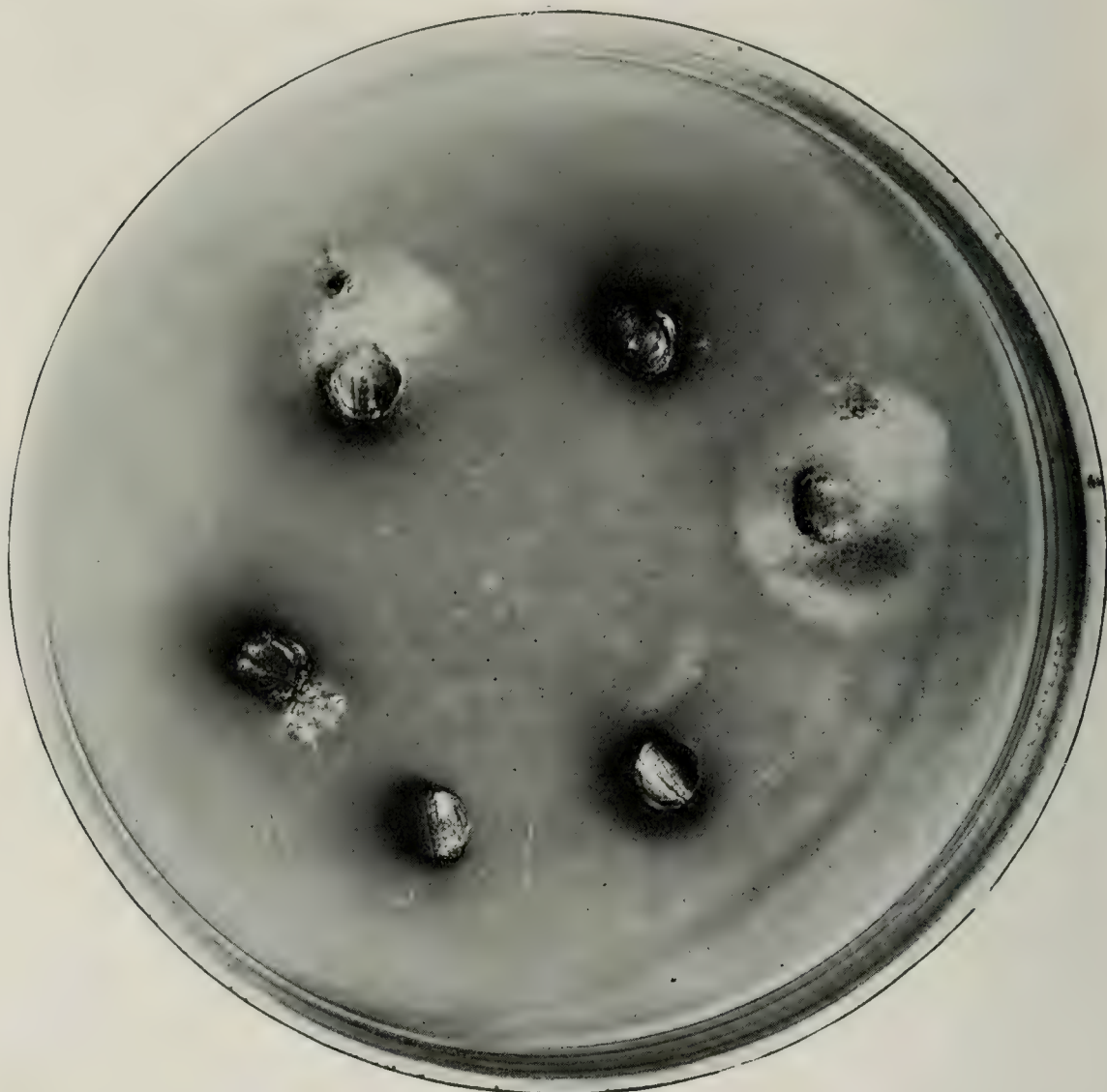


Fig. 17.—Cultural isolation of *Coniothyrium*. From three of the six slices of diseased wood *Coniothyrium* is growing, the other three remaining sterile. The discoloration in the agar around the wood slices is due to an outward diffusion of tannins and other substances from the wood.

formed in culture, but it is by no means always present. When mature the pycnidia have definite, centrally placed, regularly rounded ostioles which may or may not be raised. In agar cultures, pycnidia as large as $476\ \mu$ in diameter have been observed. The spores are one-celled, olivaceous, spherical to oblong but chiefly oval. Their range in size is $3.6\text{--}7.3 \times 2.9\text{--}5.8\ \mu$, but they are chiefly $5.1\text{--}5.8 \times 3.6\text{--}5.1\ \mu$.

When isolated from wood slices upon corn meal agar *Coniothyrium A* first grows out of the diseased pieces of wood as a short tuft of fine, whitish aerial mycelium. Within a day or two this aerial growth spreads to the agar, or additional hyphae may grow out from the wood, and a fine, whitish, regular mycelial growth is produced. Figure 17 shows a plating of wood slices from a diseased elm upon corn meal agar from which three growths of *Coniothyrium A* were secured. They



Fig. 18.—Petri-dish culture of *Coniothyrium A*, showing the appearance of the fungus 21 days after plating upon corn meal agar. Compare with Fig. 19.

had appeared two days before the photograph was made. Three of the wood slices remained sterile (corrosive sublimate was used in sterilizing them) and yielded no fungous growths. The discolored areas in the medium about the wood slices are due to an outward diffusion and subsequent oxidation of tannins. Other substances may be present also.

Within four or five days after a colony is started the central portion of the thallus darkens, becoming yellowish brown, and this extends gradually though rather irregularly in various directions, until the entire growth finally becomes dark brown or olivaceous, as shown in figure 18. Eventually the entire mycelial growth may become sparsely covered with short, white aerial hyphae. Pycnidia usually form abundantly after about ten days, at first chiefly in the darker, older

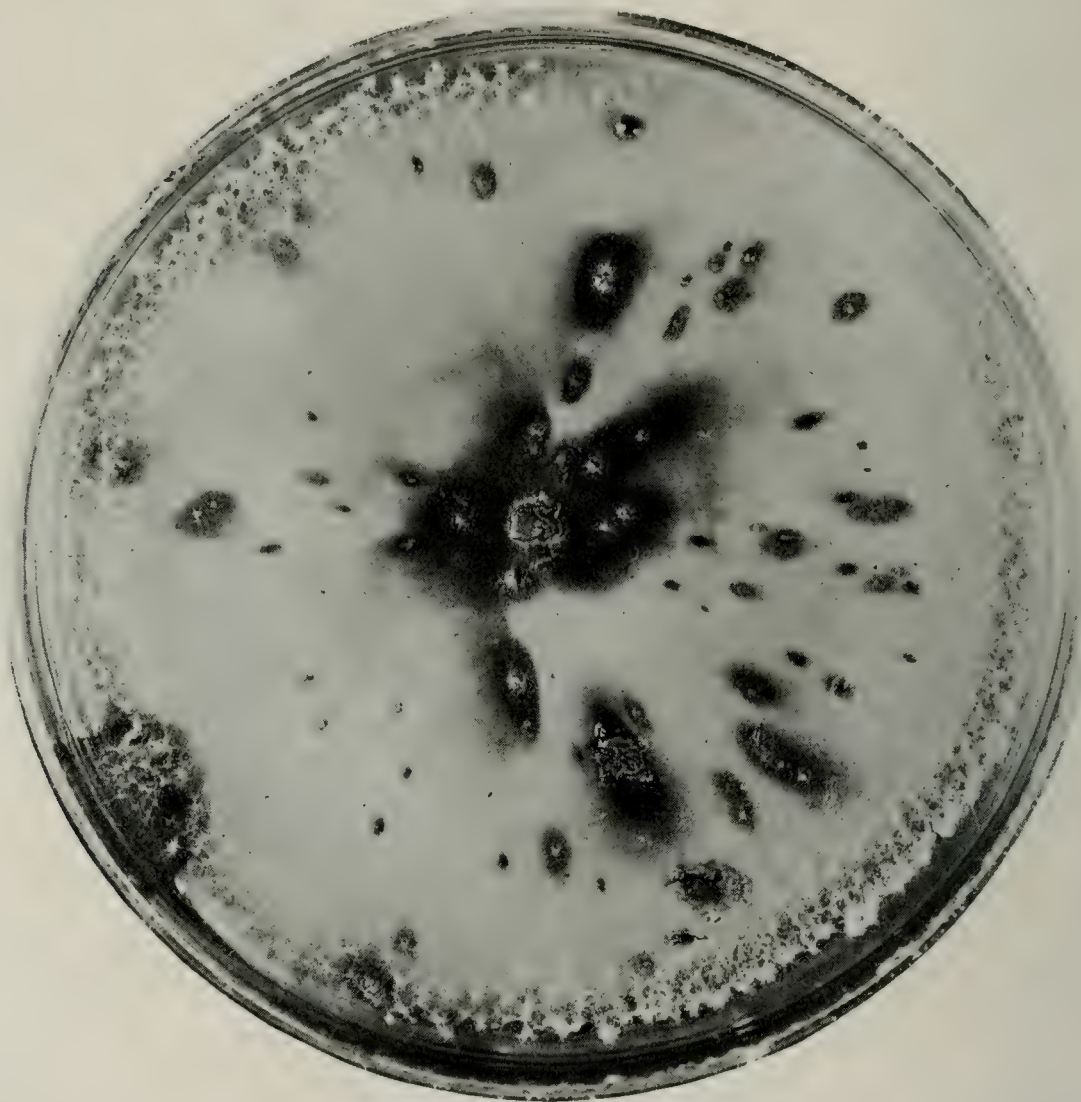


Fig. 19.—Petri-dish culture of *Coniothyrium B*, showing the characteristics of the fungus after 18 days on corn meal agar. Pycnidia are produced only in the dark areas. Compare with Fig. 18.

central portion of the growth but finally, as the thallus ages, in all parts.

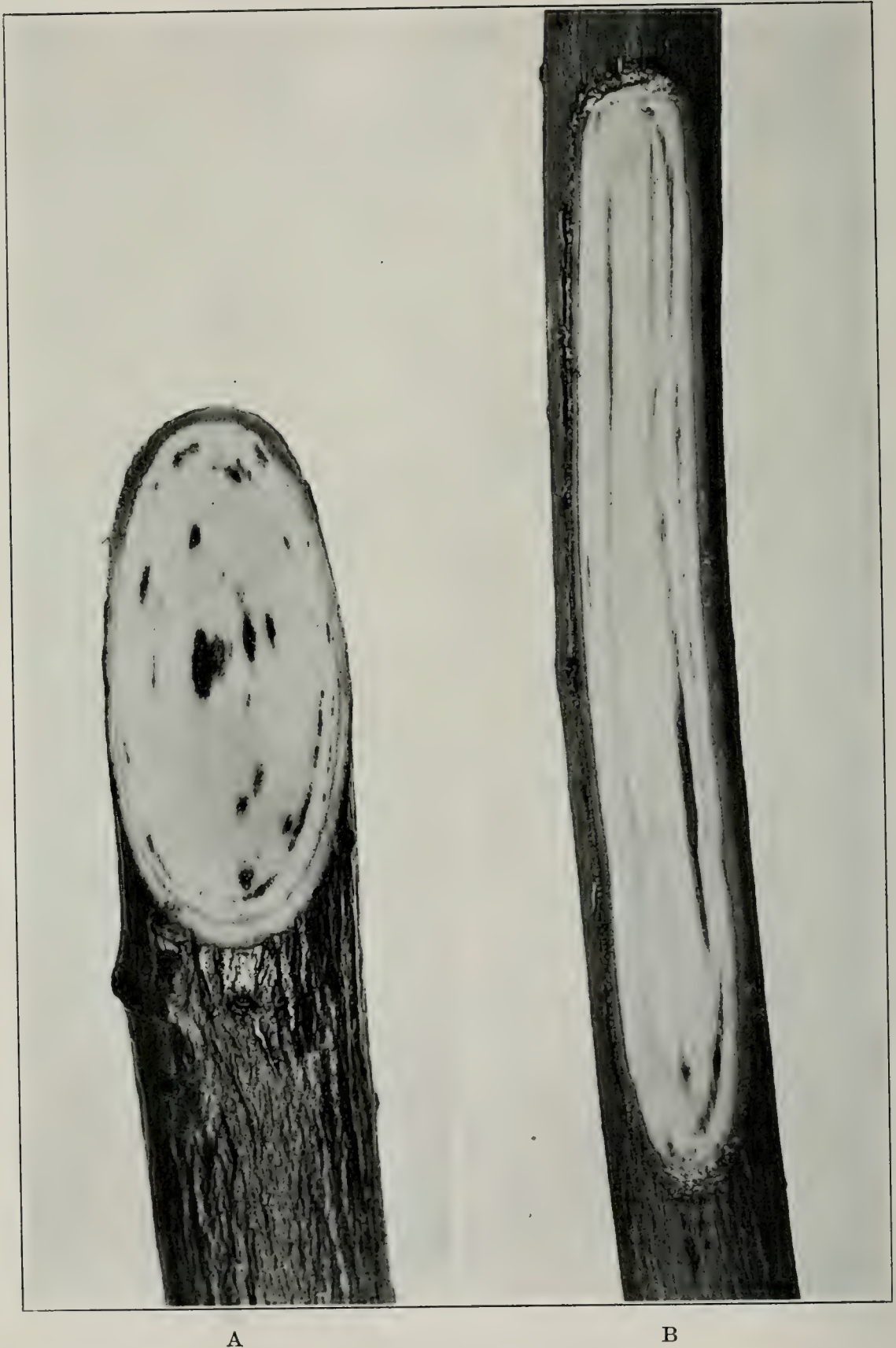
Coniothyrium B has pycnidia which are dark brown, membranous, spherical or nearly so, and with definite, circular ostioles which are darkened or carbonized at the margin. A variation in pycnidial size of $60\text{--}272\ \mu$ has been observed. The spores, in masses, vary from dark to light brown but are only dilutely colored when separate and may sometimes appear nearly hyaline. They are one-celled, ovoid-oblong to short elliptic, and measure $2.5\text{--}6.6 \times 1.4\text{--}4.4\ \mu$ but are mostly $3.6\text{--}4.4 \times 1.4\text{--}2.2\ \mu$.

In corn meal agar culture, the mycelium of *Coniothyrium B*, shown in figure 19, is at first entirely white, quite fine, and very silky in appearance, and the marginal growth is regular. It remains white and



Fig. 20.—A large elm attacked by *Vermicularia*. Twigs and branches throughout the tree die after becoming infected. Damage is done first to the upper and outermost parts, the lower and central parts of the tree remaining healthy until invaded from above. Photographed July 8, 1931.

closely appressed to the agar until the time of pycnidial formation, which usually occurs within ten to 16 days, when the central portion of the thallus and numerous scattered portions turn dark brown. Pycnidia are formed only in these dark areas, in which they are usually gregarious though they may also occur singly. Cultures are devoid of aerial mycelium, except for a circle of short, white, floccose growth near the side of the plate.



A B

Fig. 21.—Wood discoloration caused by *Vermicularia*. A.—In an obliquely cut branch, the discoloration appears as dark brown, scattered spots. The spots are most abundant in the newest wood, forming there a discontinuous ring. $\times 3$. B.—Wood discoloration shown, in longitudinal view, as long, continuous, rather broad streaks. $\times 2$.

The differences which exist between these two forms of *Coniothyrium* in their effect upon the host can be ascertained only after inoculation experiments have been completed. On diseased specimens no contrasting symptoms have been noted thus far between them though they are readily distinguishable in culture by the morphological differences condensed in table III.

TABLE III.—COMPARATIVE CULTURAL AND MORPHOLOGICAL CHARACTERS OF *Coniothyria A* and *B*.

Form	Isolation growth	Mycelium	Aerial hyphae	Pycnidia		Spores		
				Size	Ostiole	Color	Form	Size
<i>A</i>	Mycelium appears first as short aerial tufts and later grows into the medium	Entire growth eventually turns dark	Formed sparsely over the entire growth	95—476 μ	Not carbonized and often raised	Olivaceous in mass and when separate	Chiefly oval	5.1—5.8 $\times$ 3.6—5.1 μ
<i>B</i>	Mycelium grows directly into the medium without forming aerial tufts	Growth darkens only at the center and in scattered islands	Formed only in a narrow band at the margin of growth	60—272 μ	Carbonized and not raised	Pale brown to nearly hyaline when separate	Chiefly short elliptic	3.6—4.4 $\times$ 1.4—2.2 μ

According to Seymour's (1929) list two species of *Coniothyrium* are now known to occur upon elms in America. These are *Coniothyrium Fuckelii* Sacc. on *Ulmus americana* L. and *Coniothyrium Ulmi* Tharp on *Ulmus campestris* L. The latter fungus was reported by Tharp (1917) as the cause of a leaf spot in Texas. Through the courtesy of Dr. Tharp a portion of the type specimen of this fungus was secured. A comparative examination of it and the *Coniothyria* isolated from diseased elm wood showed them to be different, especially in their spore characters. The spores of *Coniothyrium Ulmi* are smaller than those of *Coniothyrium A* and larger than those of *Coniothyrium B*.

It has not been possible to secure a specimen of the *Coniothyrium Fuckelii* reported on elm. This fungus is, however, very common on

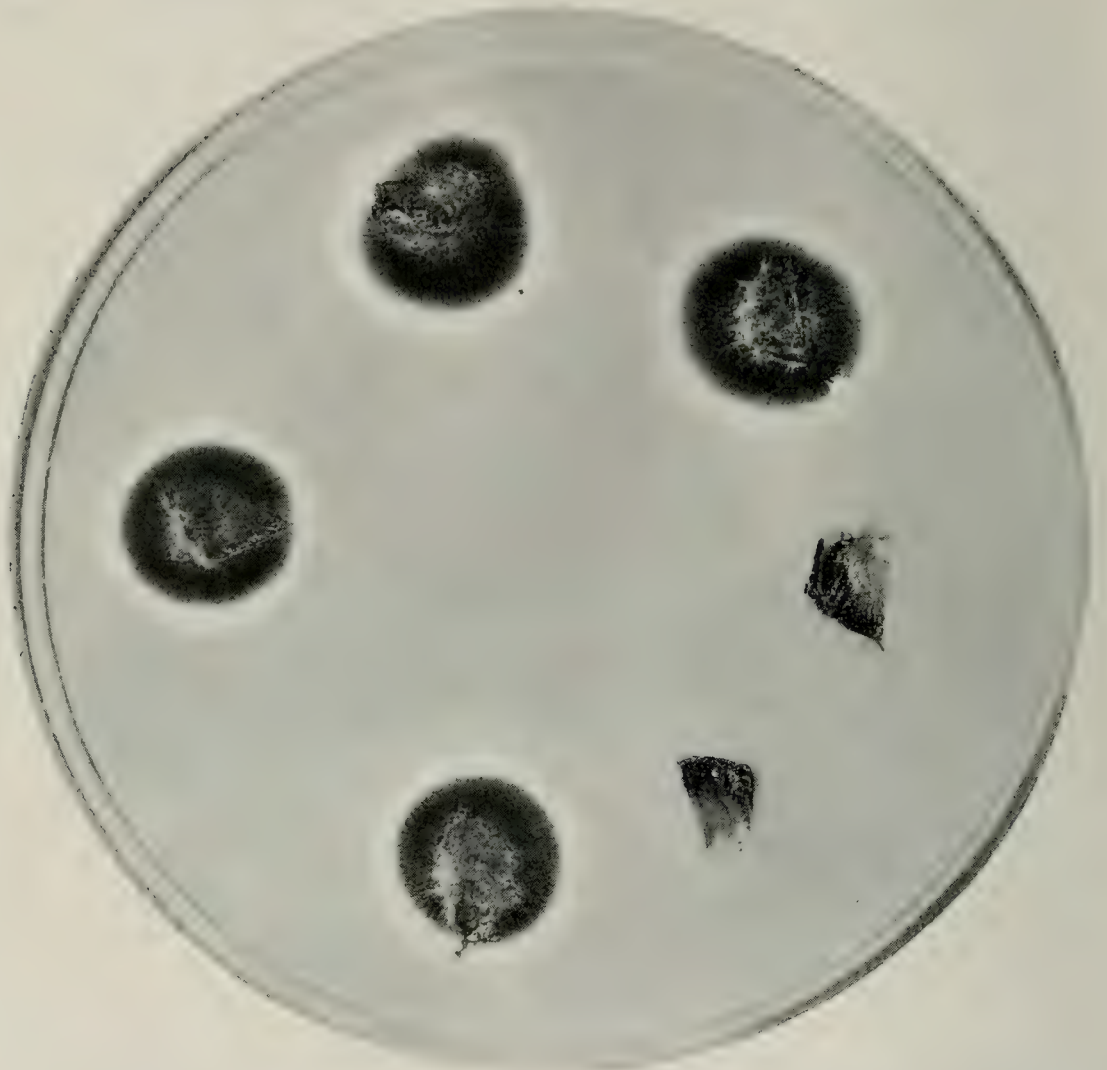


Fig. 22.—Isolation plate showing *Vermicularia* growing from infected wood slices planted on potato dextrose agar five days before photographing. Of the six wood slices four yielded *Vermicularia* growths and two remained sterile.

raspberry and material from this source has been compared with our *Coniothyria A* and *B*. Aside from having somewhat smaller spores, the raspberry form of *Coniothyrium Fuckelii* and *Coniothyrium A* are quite similar, but we are not convinced that they are identical. The characteristics of *Coniothyrium B* are not even closely approached by either of the *Coniothyria* reported on elm in America.

The fact that in "elm wilt" a definite tracheomycosis occurs presents an unusual form of attack for *Coniothyrium*. It is possible that our fungi are not to be classified in that genus, although we place them there tentatively at present.

VERMICULARIA DISEASE

On three occasions the fungus *Vermicularia* was isolated from very severely diseased trees. It was obtained each time from relatively mature shade trees and has not yet been found attacking elms in nurseries.

The first isolation was obtained from a large parkway tree in Champaign, Illinois, in May, 1931. The tree is shown in figure 1. Numerous branches that have been attacked and destroyed are noticeable throughout the entire tree but are more evident in the topmost part. Some of the larger limbs are entirely dead, others nearly so, and still others are just beginning to die at the tips. The defoliated branches so conspicuous in the top of the tree are mostly the dead tips of branches and limbs arising in the center of the tree which, though still alive, are badly diseased. The disease has developed so extensively that almost any of the upper limbs, large or small and selected at random, when cut through will show the distinct discoloration of the wood characteristic of the disease. A different view of the same tree, shown in figure 20, indicates that the diseased condition is not limited to any particular part but occurs throughout the tree. In this view the diseased branches are even more conspicuous and destructiveness of the disease is illustrated more vividly. Observations made on this tree indicate that the disease entered through the tips of branches and progressed downward. That the disease is so general throughout the top of the tree suggests also that infection occurred originally at several points rather than at a single point.

Within a diseased branch, the disease manifests itself, as shown in figure 21A, as dark brown discolored areas or blotches scattered in circles throughout the wood. In the most recently formed wood, the sapwood, discoloration appears as a narrow, continuous band or ring, such as is indicated in the photograph. When the stem is cut lengthwise discoloration consists of continuous streaks which are often rather broad and extend through the wood for a considerable distance, as shown in figure 21B.

There is no difficulty in distinguishing *Vermicularia* infection from the *Coniothyrium* tracheomycosis. *Vermicularia* produces no cankers, whereas a prominent characteristic of *Coniothyrium* is the formation of flattened, depressed, water soaked cankers along one side of the stem. The internal wood discolorations manifested by the two diseases are also different. In the *Coniothyrium* disease the discoloration occurs chiefly along one side of the stem and is diffused, while as just noted the *Vermicularia* discoloration takes the form of long streaks and is also much darker than the *Coniothyrium* discoloration.

Another isolation was made from a large elm in Urbana. The tree had a great many dead limbs, both large and small, which had apparently been dead for several years. Very few living branches remained on the tree and these for the most part were only very small twigs or shoots. Platings made from diseased branchlets about one-quarter inch in diameter, which showed large dark brown streaks

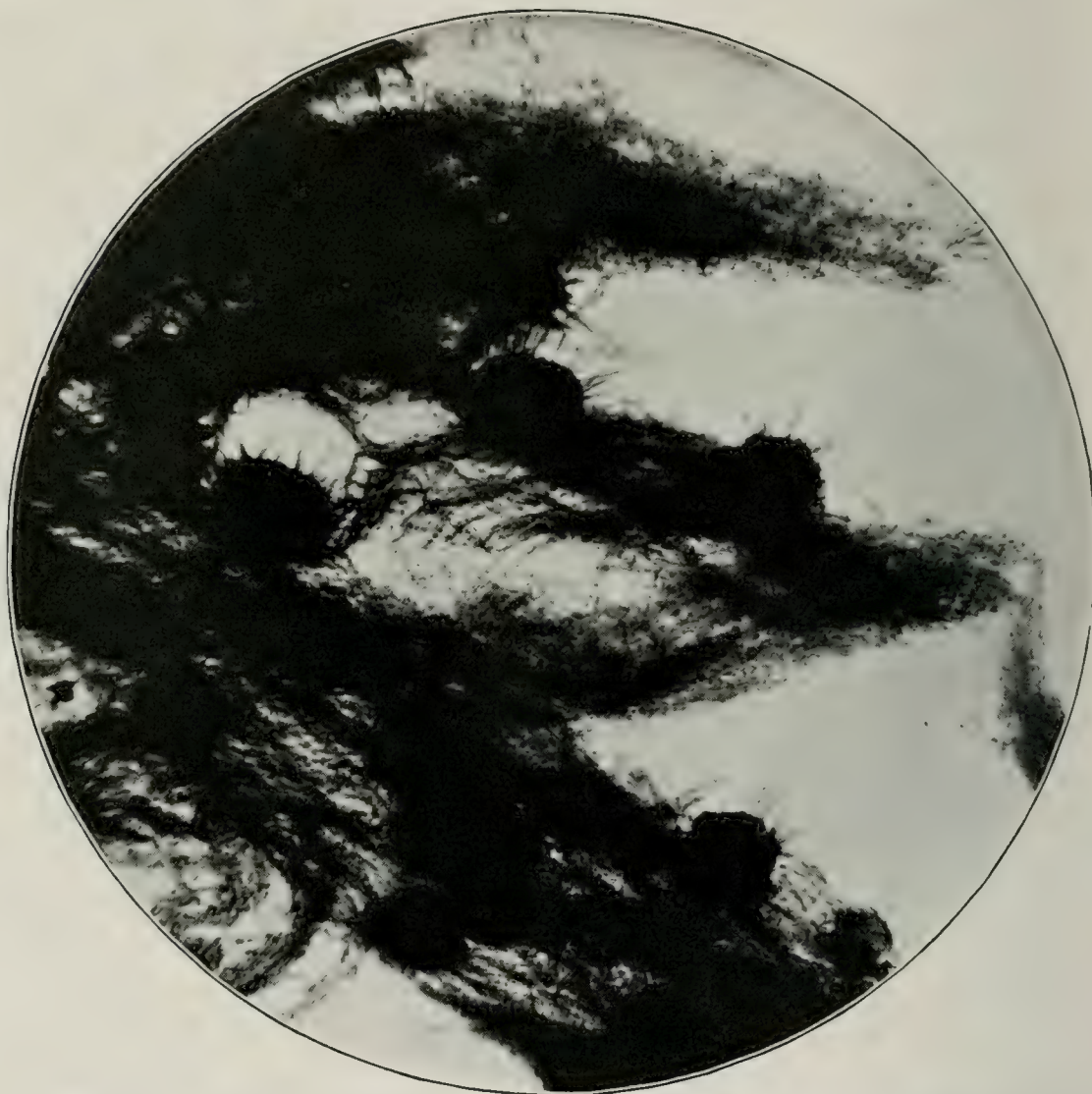


Fig. 23.—Photomicrograph, $\times 100$, of the mycelium and pycnidia of *Vermicularia* produced on potato dextrose agar. Notice the numerous setae on the pycnidia.

in the wood, yielded both *Vermicularia* and *Coniothyrium*. Both fungi were isolated from the same piece of branch and from wood slices cut from the same region with the bark removed. It seems apparent that both *Vermicularia* and *Coniothyrium* were attacking this tree. The two were not, however, derived at any time from the same slice of wood but grew out from different slices.

The third tree from which *Vermicularia* was isolated was a young Moline elm at La Grange, Illinois. It was dead, save for about 6 inches along one side of the trunk just above the ground. Upon removing the bark from this area, in the current year's wood was exposed a dark brown discoloration, which was found to extend up and down the trunk in disconnected streaks. Platings of this diseased wood yielded only *Vermicularia*. Dead material taken from the upper parts of

the tree yielded several different fungi, among which were *Anthostomella*, *Nigrospora* and *Fusarium*.

The original culture-plate isolations made from the diseased elm pictured in figures 1 and 20 are shown in figure 22. Wood slices were planted on potato dextrose agar and when photographed after five days, fungous growths from four of the six slices had attained a diameter of a little over 1 cm. The mycelial growth of *Vermicularia* is characteristically quite compact. Three regions are readily distinguishable: the central and greater portion is dark green; the second, surrounding the first, is a narrow zone of light green; and finally, the marginal growth consists of whitish mycelium and actively growing hyphal tips. A heavy, floccose, grayish aerial mycelium eventually covers the central portion of the thallus, but it is only slightly developed on the younger growth.

The pycnidia of *Vermicularia* have not yet been found on diseased elms, but they are formed abundantly in culture. They are dark brown, membranous, globose and without ostioles. The lower portion is frequently immersed in the mycelium. They usually occur singly, though they are sometimes formed in groups of two and three. As shown in figure 23, their walls are covered with light brown, simple, often septate setae. These setae, however, are produced in abundance only when the fungus has been recently isolated. After it has been grown on artificial media for a while setae are usually no longer formed or at most they are but poorly developed. Pycnidia formed in culture vary 40—122 μ but are chiefly 80—95 μ in diameter. The pycnidiospores are very minute, hyaline, single-celled and chiefly oblong, but vary to short elliptic or bacilliform. Their range in size is 1.8—3.6 $\times$ 0.7—1.4 μ but they are chiefly 2.2—2.9 $\times$ 1.4 μ .

PHOMA CANKERS

From the great frequency with which its fructifications are found on diseased elm specimens, *Phoma* appears to be very prevalent. In isolation tests of diseased trees, however, it has been obtained only 19 times. Whenever it was obtained from trees it was accompanied by heavy discoloration of the sapwood. Though *Phomas* are often thought to be saprophytic bark inhabitants, evidence of the pathogenic nature of those derived by us from diseased elms is found in the fact that they have been isolated from slices of diseased but living wood from which the bark had been removed previous to plating.

As nearly as observations will permit us to say at this time, the *Phoma* disease is limited in its pathological effects to the production of thickened, raised, smooth cankers of the kind shown in figure 4A. Young cankers are light brown and smooth, and do not have pustules.



Fig. 24.—Petri-dish culture of *Phoma A.* On corn meal agar it forms a decided dendritic type of mycelial growth, and pycnidial formation is entirely lacking. Compare with Fig. 25.

The cankers enlarge, often symmetrically, up and down the stem and as they grow older, pycnidial pustules break through the dead bark singly or in groups and eventually occur in great abundance, as is shown in figure 4B. Often small cankers in proximity coalesce to form a larger canker.

The *Phoma* attack is also accompanied by a rather characteristic wood discoloration, which is shown in transverse and longitudinal views in figure 5. A comparison of the *Phoma* discoloration with that of *Coniothyrium* illustrated in figures 7B and 9, shows very little difference. In both it is of the diffused type. The *Phoma* discoloration is usually present, however, along all sides, as the lengthwise cut in figure 5 shows, while the *Coniothyrium* discoloration is usually limited to one side of the stem. The pycnidial pustules which dot the *Phoma* cankers afford a conspicuous character by means of which *Phoma* and

Coniothyrium infections can be distinguished in the field, provided older cankers of both diseases are present. In addition, the thick and raised *Phoma* canker, which may extend almost or entirely around even a large branch contrasts strongly with the flat, sunken *Coniothyrium* canker, which usually extends along only one side. In very early stages, however, it is difficult, sometimes impossible, to distinguish the two diseases with certainty, except by isolating the fungi from diseased material.

The *Phoma* pycnidia are membranous and usually flask shaped, though often globose, and have raised ostioles which are rather definitely carbonized around the margin. They are often so crowded as to be contiguous, though they are never continuous, and protrude through the bark singly and in twos or threes. Their range in diameter is 120—275 μ but they are chiefly 135—150 μ . The ostiolar aperture may vary from 25 to 40 μ wide. The exceedingly minute, hyaline, single-celled, bacilliform pycnidiospores are commonly biguttulate, though not always or prominently so, and range in size from 1.8—4.4 $\times$ 1.1—4 μ , but are chiefly 2.9 $\times$ 1.4—1.8 μ .

Two distinct strains of *Phoma* have been secured in isolations from diseased elms. Though alike in pycnidial and spore sizes, they differ greatly in their behavior in culture. For convenience they are referred to in this discussion as strain A and strain B.

Strain A seems to be more prevalent than strain B, since it has been isolated from diseased elms the greater number of times. It has failed consistently to produce pycnidia in cultures on various agar media, but it does produce them in great abundance on sterilized elm twigs. On corn meal agar this strain forms an irregularly radiating, branching thallus with a dendritic type of growth, as may be seen in figure 24. Occasionally, zones are formed in the mycelial growth. The mycelium early turns light brown, and this deepens to dark brown as the fungus becomes older. Short, grayish, aerial hyphae arise over the entire growth, but denser tufts are scattered over the surface and are particularly abundant in the central portions. This strain forms numerous small, dark, round structures which closely resemble pycnidia when they are seen macroscopically in a colony, but when examined with a microscope they are found to consist only of a sclerotial aggregation of hyphal cells which does not undergo further differentiation.

Strain B forms a type of growth in culture altogether different from that of strain A, as may be seen by comparing figures 24 and 25. When first isolated, the mycelial growth is dark green and forms numerous concentric zones. After it has grown in culture for some time, this zonation is only slightly evident and the mycelium becomes



Fig. 25.—Petri-dish culture of *Phoma B.* On corn meal agar. The concentrically zonated, fine mycelium produces pycnidia in great abundance. Compare with Fig. 24.

light olivaceous or yellowish brown. Pycnidia are, however, produced very readily and abundantly.

No morphological differences have been found by which these two strains can be distinguished when the pycnidia occur on infected stems or branches of elms. Neither are there any differences between the two strains on sterilized elm twigs.

From four diseased trees a third type of *Phoma* has been isolated. In culture it always appeared, after a short time, to become contaminated by *Alternaria*. The *Alternaria* has appeared constantly in all isolations of this *Phoma*, though the greatest care has been used to grow the *Phoma* in pure culture, separate from the *Alternaria*. Twenty single-spore isolations have been made of the *Phoma*, but in each the *Alternaria* has developed. It is believed that this elm *Phoma* is simi-

lar to *Phoma alternariaceum* Brooks and Searle (1922), which attacks the tomato and which has been shown by Chordat (1926) to have both *Phoma* and *Alternaria* as conidial forms. It is not known whether this polymorphic elm *Phoma* is pathogenic, but the fact that in isolation trials it grows out from the bark instead of the wood suggests that it may be only a saprophyte.

SPHAEROPSIS DIEBACK AND CANKER

Sphaeropsis dieback and canker was first described by Hubert and Humphrey (1920) as causing extensive damage to shade and nursery elms in Wisconsin. It was later stated by Hubert (1931) to occur also in Pennsylvania, Maryland and Ohio. We have found it on elms in nurseries in Illinois also, but it is of infrequent occurrence and is of only minor importance among elm diseases in this state.

The *Sphaeropsis* canker of elm is caused by *Sphaeropsis ulmicola* E. and E. The first evidence of its presence is a dying and discoloration of the tips of small branches throughout the top of the tree. From these the infection spreads downward into the larger limbs and finally into the lateral branches. Early death of the top branches produces a stag-headed appearance. Secondary shoots often grow out below the dead limbs, resulting in the formation of witches' brooms. Reddish brown to brownish black cankers which are often mottled by black areas are formed on the stem. Beneath the canker the cambial layer and the wood are discolored reddish brown. In older infections a darker discoloration of the wood is present. The ostiolar apertures of numerous small, black pycnidia produced beneath the bark in the cankered areas barely protrude above the surface by small necks and form pimple-like eruptions.

The scattered pycnidia are minute, 200—300 μ in diameter, white within, and form erumpent epidermal pustules but commonly do not break the covering; the conidia are ellipsoid or obovate, 20—30 $\times$ 12—15 μ , and yellowish brown; the conidiophores are shorter than the conidia and obtuse.

PHOMOPSIS CANKER

The *Phiomopsis* canker has been found several times in Illinois on diseased elms. The pycnidia of the fungus occurred abundantly in the cankered areas but contained only the small *alpha*, or *Phoma*, type of spore. When the fungus is grown in agar cultures, it does not fruit but gives only a whitish vegetative mycelium which, in age, turns green. Small sclerotial aggregations of hyphal cells are formed in various parts of the cultures but never develop into fructifications. Recently, however, a culture growing on sterilized elm twigs formed pycnidia which contained both the oval *alpha* spores and the long,

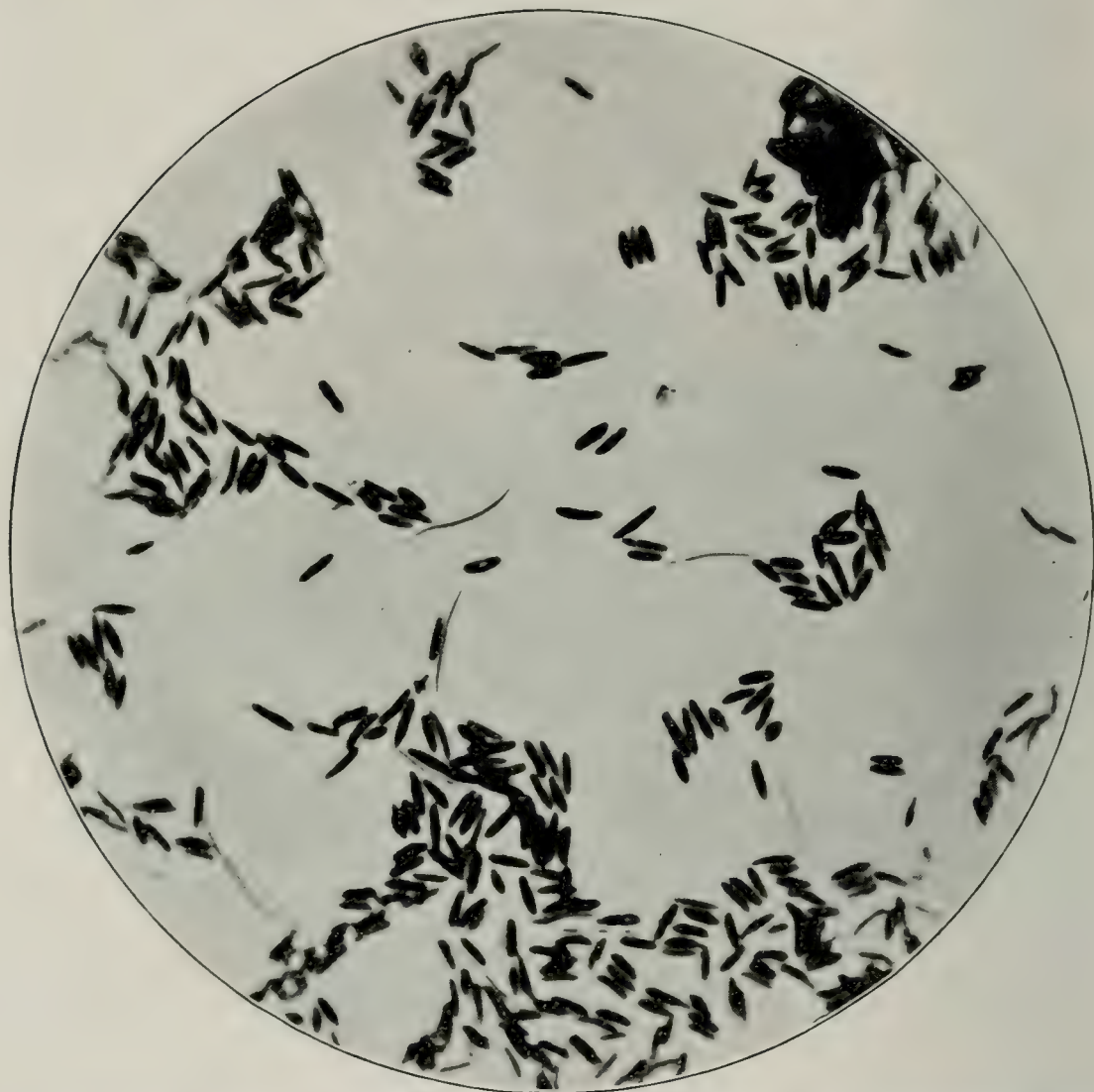
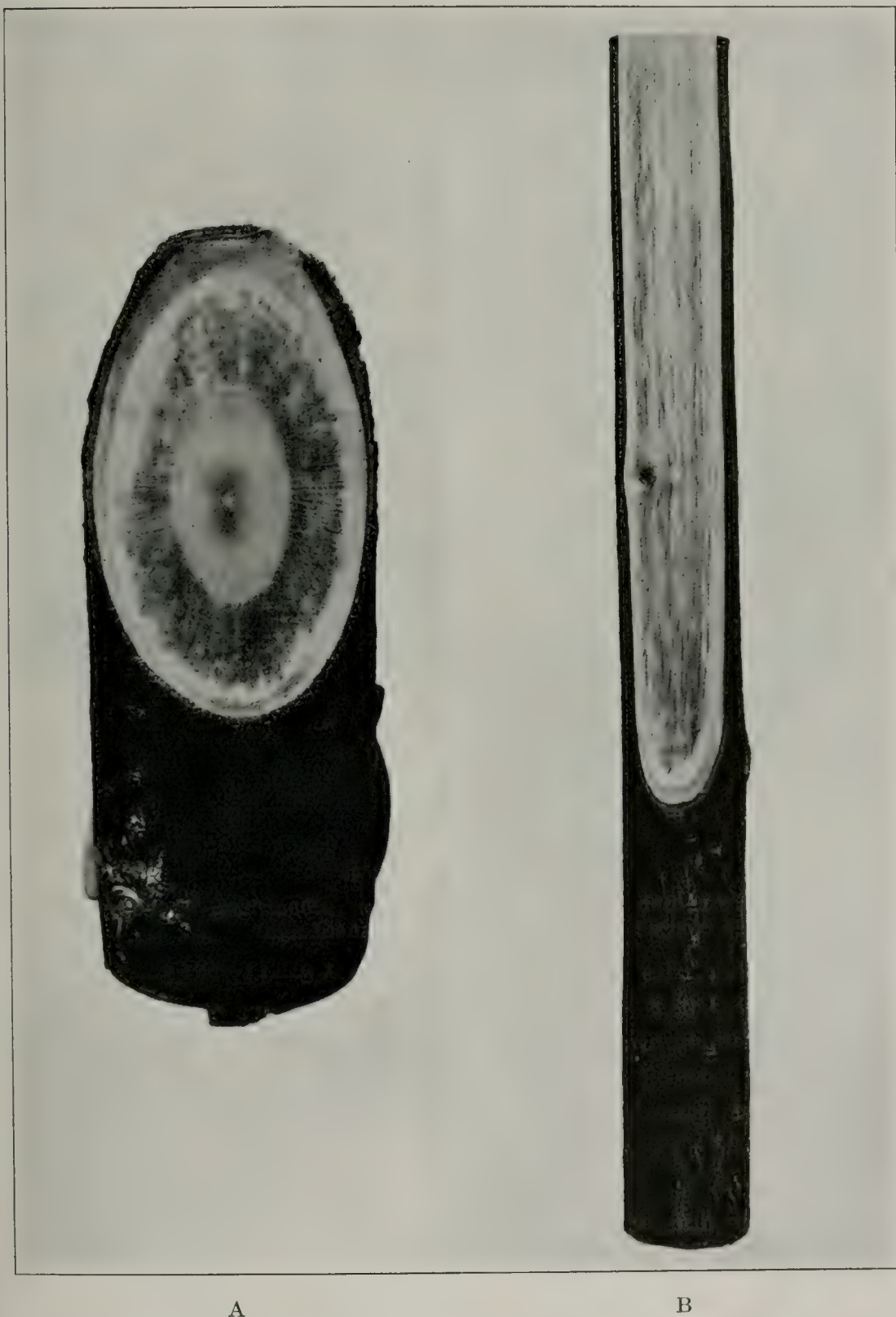


Fig. 26.—Photomicrograph, $\times 1000$, of the spores of *Phomopsis*. The two types of spores are produced in cultures grown on sterilized elm twigs. The slender stylospores occur less frequently and are produced in a lesser number than the oval *alpha* spores.

slender, curved *beta* or stylospores. The two types of spores are shown in figure 26. This definitely establishes the fungus as a species of *Phomopsis*.

A *Phomopsis* parasitic upon elms was found also by Buisman (Westerdijk en Buisman, 1929) in connection with her investigations of the Dutch elm disease in Holland. She found the ascigerous form of the Dutch *Phomopsis* to be *Diaporthe*. Recently Richmond (1932) reported that a cankerous disease of the American elm in eastern Massachusetts was due to a *Diaporthe* which had a *Phomopsis* as an imperfect stage. Comparisons were made of this fungus with the *Diaporthe* studied by Buisman and it is stated that the two appear quite similar. Though a perfect stage of the *Phomopsis* isolated in Illinois has not as yet occurred in culture, the *Phomopsis* from Illinois elms agrees very closely in spore size with the *Phomopses* of Buisman



A

B

Fig. 27.—Internal wood discoloration caused by *Verticillium*. A.—In an obliquely cut branch, it appears as a general, diffused browning resulting from the discoloration of the water conducting vessels. The ray tissues, however, are not discolored. $\times 2\frac{1}{2}$. B.—In longitudinal view, the discoloration consists of fine, short, disconnected brown lines. $\times 1$. Compare this with the discoloration shown in Figs. 5, 7 and 21.

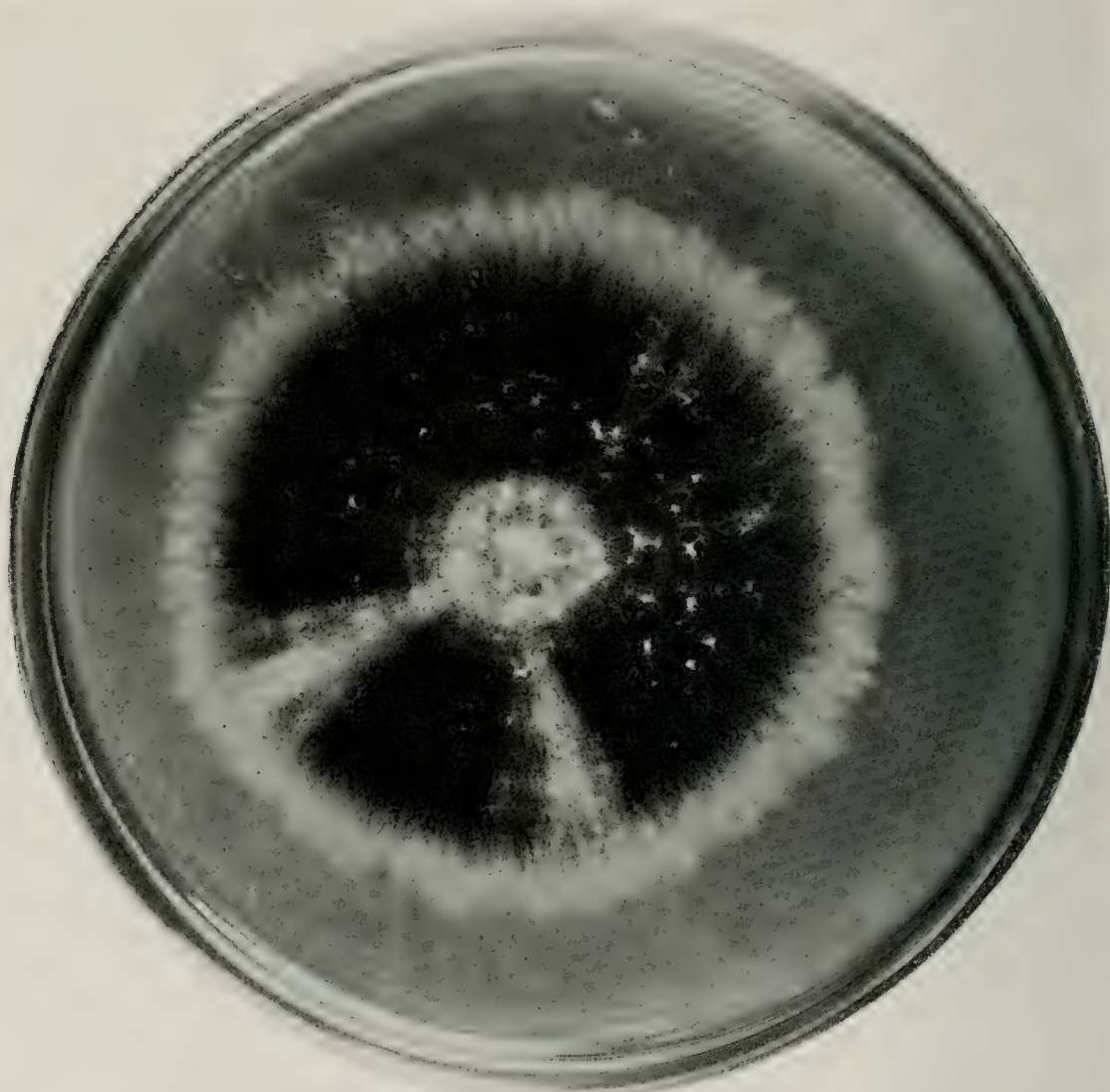


Fig. 28.—Petri-dish culture of *Verticillium alboatrum*, showing the appearance of the fungus after 12 days on corn meal agar.

and Richmond. Its *alpha* spore range is $5.8-11.7 \times 1.8-3.3 \mu$ but chiefly $7.3-8.8 \times 2.2-2.5 \mu$, and the *beta* spores are mostly $23.2 \times 1 \mu$. The Dutch *Phomopsis*, according to Buisman, has *alpha* spores which are generally 7.1×2.4 and stylospores $25 \times 1 \mu$. The *Phomopsis* studied by Richmond has *alpha* spores $6.5-8.2 \times 2.7-3.5 \mu$ and stylospores $22.7-27.5 \times .98-1.3 \mu$.

VERTICILLIUM WILT

The wilt due to *Verticillium alboatrum* Reinke and Berth. has been found but once among the numerous cases of disease examined and cultured in this investigation. It is, however, said to be of frequent occurrence in certain localities in the state, especially near Hillsboro. The tree from which *Verticillium* was isolated in our study was in a northern nursery.

The *Verticillium* disease affects elms in much the same manner as it does other plants or trees. It forms no cankers on the affected parts



Fig. 29.—Photomicrograph, $\times 100$, of perithecia of *Anthostomella* produced in culture. Numerous ascospores are shown, but the asci enclosing them, being hyaline, are invisible.

and the only external symptoms are a drooping and wilting of the foliage either over the entire tree or only on certain branches. An elm infected with *Verticillium* has the same appearance that any plant or tree would have when wilting from lack of water. *Verticillium* wilt is characterized, however, by a distinctive type of wood discoloration. In a transverse cut of a twig, as in figure 27A, the discoloration is restricted entirely to the woody tissue. It is not necessarily limited to certain portions but may occur throughout the wood and extend into new wood as it forms during the season. The fungus may continue to invade the woody structure until the tree dies. In the transverse cut shown in figure 27A there is so much discoloration that it appears diffused and like the *Coniothyrium* and *Phoma* discolorations. Its distinctive character is best seen, however, in a longitudinal cut such as that shown in figure 27B. Here the discoloration is shown to consist of a multitude of very short, brownish, longitudinal streaks. These

stand out more clearly in a fresh specimen than they do in the photograph.

The *Verticillium* wilt is difficult to distinguish from the Dutch elm disease by symptoms alone. Both the wilting and internal wood discoloration caused by the Dutch elm infection are very similar to those of the *Verticillium* wilt. According to May (1931a), however, the discoloration, *i. e.*, the streaking, is more continuous in *Verticillium* wilt than in the Dutch elm disease; but an absolute diagnosis of either disease is dependent upon a cultural isolation of the associated fungus.

A plate culture of the *Verticillium* isolated from elm in Illinois is shown in figure 28. The abundant formation of sclerotial masses characteristic of most *Verticillia* when growing upon artificial media and the floccose growth of whitish, aerial hyphae which occurs in various parts of the plate, are evident. The mycelium of the fungus is endogenous, effused, and becomes dark; fertile hyphae are emergent, erect, simple, dark, paler above, verticillately branched, and few-septate; terminal branches are ascending; conidia are ovate-oblong, continuous, hyaline to very dilutely colored, $6-12 \times 3 \mu$.

OTHER INFECTIONS

IN addition to the definitely recognizable diseases just described, various samples of diseased material have been examined which have yielded a variety of fungi commonly considered to be parasitic or to cause wood or bark rots. These are described below.

FUSARIA

Not less than three species of *Fusarium* are included among the ten isolations of this genus that have been obtained. Of these, one has been called *F. scirpi*, var. *compactum* by C. D. Sherbakoff and by H. W. Wollenweber, though that determination was not wholly satisfactory and simply avoided the making of a new name. Dr. Sherbakoff states in his letter that he has had the same fungus sent to him on several occasions from Texas, where it had been isolated from cotton, and that he has grown it in culture from Texan and other soils.

A second form Dr. Sherbakoff believes to resemble *F. oxysporum* Schl. (Section *Elegans*), but it does not yield very good sporulation and does not possess other earmarks by which he could identify it definitely. The third form has not yet been identified, and may subsequently be found to include more than one species.

The form called *F. oxysporum* predominates among our isolations. In culture it produces but few macroconidia. Microconidia and chlamydospores are produced abundantly, however. It is entirely white in its early growth upon corn meal agar and has a silky, rather

slimy appearance, due to the numerous microconidia produced in roundish clusters either directly along the sides of the hyphae or upon short, simple conidiophores. Later the mycelial growth darkens to yellowish brown. The microconidia are hyaline, single-celled and vary somewhat in size and shape. They are usually ovate to elongate-obovate and their size range is $4-16.1 \times 3.3-8.4 \mu$, but chiefly $6.6-9.5 \times 4.4-6.9 \mu$.

CEPHALOSPORIUM

In addition to the *Fusaria* discussed above, isolations have been secured of fungi which are apparently true *Cephalosporia*. In their early growth upon potato dextrose agar these colonies are hyaline and very slimy on the surface. Later the central portion becomes light yellowish brown and ultimately dark brown or olivaceous. Short, sparse, grayish, aerial hyphae arise in the central portion and to a limited extent over the entire growth. A slight, irregular zonation also occurs in the central portion of the growth. The conidia are hyaline, single-celled and usually biguttulate, though they often contain three or four small oil globules. They arise either directly from the growing mycelium or upon very short, simple conidiophores. They vary greatly in shape but are usually elongated and slightly curved. From a culture of the fungus grown on potato dextrose agar a range in spore size of $4.3-10.2 \times 1.4-2.9 \mu$ was noted. Chiefly they are about $5.8 \times 2.2 \mu$.

These are not all, however, identical with the *Cephalosporium* recently described by May (1931b) as the cause of a new elm disease in Ohio, Iowa, Missouri, New York and Washington, D. C., since a culture submitted to May for comparison was stated to be different.

ALTERNARIA AND STEMPHYLIUM

Alternaria has been obtained in the isolation trials more times than any other fungus. As its conidia and mycelium occur very commonly on dead material it is believed to be saprophytic or, at most, only a weak parasite. Its mycelium does not penetrate into the woody or deeper tissues of the stem but is limited to the outer, corky tissue of the cortex. Consequently no extensive injury could result from its presence. Very young twigs which have just died and which have a very shriveled appearance have been observed to be almost completely covered by the black, dusty spore masses of *Alternaria*. Since the mycelium of *Alternaria* penetrates the bark tissues to some extent, it is very difficult to destroy by any method of surface sterilization before platings are made of samples of disease, and this readily accounts for the numerous occurrences of the fungus in platings of wood slices upon which the bark was left intact. The fungus has never grown out of slices from which the bark had been removed previous to plating.

The importance of *Stemphylium* in its relationship to elm diseases is also undetermined. It has not been isolated as frequently as *Alternaria*, though it usually occurs as a growth decidedly secondary to that causing the disease. Our observations indicate that *Stemphylium*, like *Alternaria*, is also essentially bark inhabiting, since its mycelium grows in the outer tissues of the bark and not in the wood.

ANTHOSTOMELLA

Anthostomella is the only ascomycetous fungus which has been obtained directly in culture. It has been secured twice and in both instances apparently grew out of the bark. In one case it was isolated from the dead wood of a Moline elm along with *Nigrospora* and *Fusarium*. Living, diseased wood from the same tree yielded *Vermicularia*. In the other instance it was isolated along with *Stemphylium* and *Alternaria* from an American elm.

The perithecia of *Anthostomella*, shown in figure 29, are produced very abundantly in culture upon corn meal agar. They form upon the plated wood slices and the glass sides of the plate as well as upon the

agar itself. They are black, flask shaped, and provided with raised ostioles, and their walls are somewhat roughened and carbonous. A range of 204—394 μ has been noted in their size in culture. In figure 30 a single ascus with its eight ascospores is shown. The asci are cylindric, hyaline, eight-spored, aparaphysate, and open by an apical pore. They measure 158—180 $\times$ 12—16 μ . The ascospores are brown, one-celled and elliptic, with a size range of 16.6—26.6 $\times$ 8.3—13.3 μ but chiefly 19.9 $\times$ 10 μ . No imperfect spore form has occurred in our cultures.



Fig. 30.—Photomicrograph, $\times 400$, of an ascus and spores of *Anthostomella*, showing the regular end-to-end arrangement of the eight spores. The apical pore of the ascus is not clearly visible.

CYTOSPORA CANKER

Dead stems and branches of elms are commonly covered by the pustules of *Cytospora*, but it has as yet been obtained only once as an isolation from plated wood slices.

Discolored wood, which often occurs below dead areas occupied by this

fungus, generally either gives no fungous growth in culture or yields other fungi. *Cytospora* apparently does not fruit readily in culture. Numerous platings have been made from single-spore isolations and an abundant vegetative growth was secured but thus far only a single pycnidium has been formed on agar. It does, however, produce its pycnidia in great abundance when grown upon sterilized elm twigs.

The stromata are depressed-conical, gregarious, subepidermal, eventually erumpent, and dark gray with the disc paler, and the conidia are allantoid, $3.3\text{--}7.3 \times .8\text{--}2.1\text{ }\mu$ but chiefly $6.6 \times 1.1\text{ }\mu$, hyaline. The fungus is apparently *C. ambiens* Sacc.

DIPLODIA CANKER

Cankers bearing the pycnidia of a *Diplodia* have been found several times on diseased elms. The fungus has been grown in artificial culture from single spores segregated by methods previously described, but it has never been isolated directly from slices of diseased wood.

In attempting to determine the proper species name for the *Diplodia* on elms in Illinois, it was found that, though *D. Ulmi* had been described by Dearness (1916), the spores as measured by him were much smaller than the spores produced by the Illinois material. A portion of Dearness' type specimen was obtained for examination, and it was found that the spore measurements given in Dearness' description were in error, at least so far as the part of his material examined by us was concerned. A comparison is given in table IV of the measurements given in the description of *Diplodia Ulmi* and of the measurements obtained by us from 100 spores of the type material and of the Illinois elm fungus.

TABLE IV.—SPORE MEASUREMENTS OF *Diplodia Ulmi* Dearn.

Source of measurements	Length, in microns				Width, in microns			
	Extremes	Mean	Stand-ard deviation	Prob-able error	Extremes	Mean	Stand-ard deviation	Prob-able error
In description.....	15—17				9—10			
Type specimen.....	19—29	23.65	± 1.86	$\pm .126$	8—11.5	10.29	$\pm .607$	$\pm .059$
Illinois material.....	19—26.5	23.42	± 1.62	$\pm .109$	8.5—13.5	10.65	$\pm .931$	$\pm .093$

Even the minimum spore length measurements taken from the type samples exceeds the maximum spore length given in the description. The measurements of spore width, however, nearly approximated those given in the description. From the measurements given in the table there is no reason to doubt that the Illinois fungus is properly designated as *Diplodia Ulmi* Dearness, though the description of the species requires emending as follows.

Pycnidia scattered but abundant, 250—400 μ in diameter, occurring singly or in small groups, subglobose, immersed in the cortex, raising the epidermis in small, scarcely visible pustules which are ruptured by the minute ostiole. Conidia brown, elliptic, constricted at the septa, $19.3\text{--}29.2 \times 8.3\text{--}11.6$ μ . Mean spore size, 23.6×10.3 μ .

On corn meal agar, *Diplodia Ulmi* produces a whitish mycelial growth provided, in its early stages of development, with sparse, grayish, aerial hyphae. Later the mycelium darkens, becoming green and finally black. Eventually, as the agar is utilized, the entire growth assumes a charred appearance. During the early growth of a culture numerous round, definitely carbonized, cellular structures are formed which have the shape of rudimentary pycnidia, but they never develop an ostiole and always remain sterile, when crushed yielding only masses of oil globules. When cultures are kept until the agar substratum becomes dry and hard, true pycnidia which do yield the characteristic brown, two-celled spores occur in aggregations at various places in the thallus. The full process of pycnidial formation has not been observed, but it is probable that the cellular structures mentioned above furnish a pseudostroma upon which the pycnidial aggregations are formed later.

NIGROSPORA

This fungus has been isolated thrice from diseased elms. Each time it grew from wood slices which were plated with the bark still upon them. Other fungi which we consider of more importance in causing elm diseases were obtained from the same material which yielded *Nigrospora*. The identification of this fungus was established for us by E. W. Mason, of the Imperial Mycological Institute, as *Nigrospora sphaerica* (Sacc.) Mason. Mason (1927) believes that the proper generic designation of this kind of fungus, one species of which causes a severe cob rot of corn and is known in the United States as *Basisporium gallarum*, is *Nigrospora*.

In its early development from platings upon corn meal agar the fungus appears as a hyaline growth with very little aerial mycelium. Later, as the thallus grows older, it assumes a brownish tint and becomes covered by a rather compact cottony growth of white to slightly grayish, aerial mycelium. In old cultures the mycelium from which

conidiophores arise is very dark brown and has thicker walls than the ordinary vegetative mycelium, which is either light brown or hyaline. As may be seen in figure 31A the spores of *Nigrospora* are formed in great abundance in culture. The conidiophores, figure 31B, may be either short and simple or rather long and several-septate. They are always swollen or enlarged at the apex, which is the point of spore attachment. The conidia are globose or nearly so, smooth, brown when young and opaque black when mature. They usually arise singly on conidiophores though occasionally a conidiophore may branch at its apex so that two or three conidia occur there. From a culture of the fungus grown upon corn meal agar a range in spore size of 14.0—20.7 μ was noted, though the spores were chiefly 16.6 μ .



A

B

Fig. 31.—*Nigrospora sphaerica*, one of the unusual saprophytic fungi isolated from diseased elms. A.—Mycelium and spores $\times 60$, as produced in corn meal agar culture. B.—A septate sporophore with a spore at its apex. $\times 550$.

XYLARIA

A *Xylaria* isolated from wood slices taken from a diseased elm in Illinois furnished one of our most interesting finds. Various species of the genus *Xylaria* are associated with and believed to be the cause of serious root rots of apple trees, maple, basswood, cottonwood, black walnut and white and red oaks. Outward symptoms shown by infected trees are dwarfing and discoloration of the crown; identification of the disease generally depends upon the presence of fruiting bodies of the fungus upon infected roots and in the debris at the base of the tree.

It is, however, very unusual for the fungus to penetrate into the upper branches of attacked but still living trees, and so far as we are aware it has never before been isolated directly from small twigs situated toward the ends of living branches.

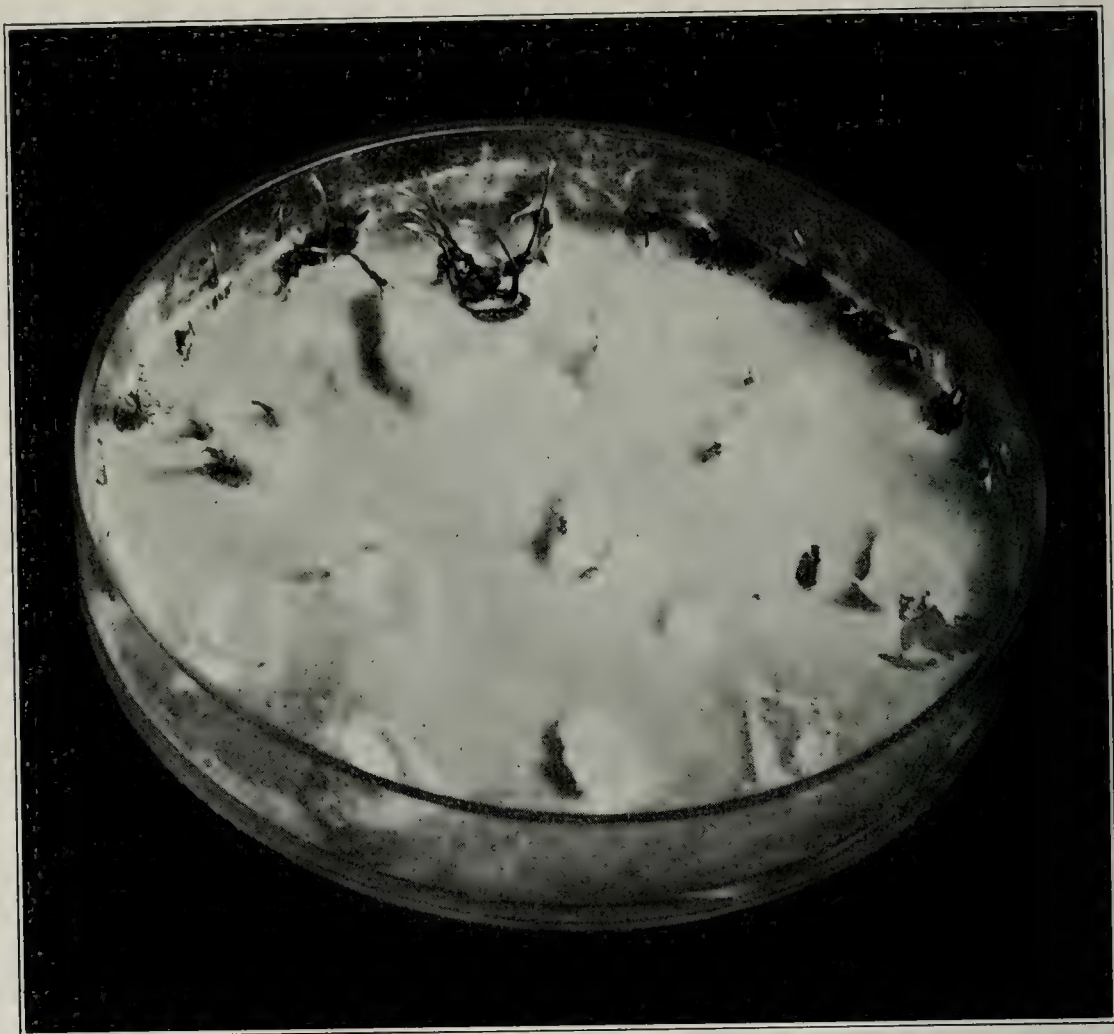


Fig. 32.—Petri-dish culture of *Xylaria*, showing its white, cottony mycelium and a number of black stromata in various stages of early development, after 30 days on acidified potato dextrose agar.

An early stage in the development in culture of the elm *Xylaria* is shown in figure 32. In its early growth the mycelium is dense, cottony and pure white. Later, after having spread over the entire culture plate, the mycelium darkens, ultimately forming very black, irregular blotches either at the edge of the plate, or around or upon the wood slices from which it grew. At the same time that the black patches are formed, or even while the mycelium is still white, stalk-like structures such as are shown in figure 32 begin to grow up from the mycelium.

The fungus is shown in figure 33 as it appeared six weeks after the stage pictured in figure 32. The tips of the stalks have remained white, although as they grew the lower portions gradually turned black. Also, a considerable area in the mycelium around the base of the stalks eventually turned black.

The stromata, that is, the stalks, of this fungus exhibit the same very strong positive phototropism that is characteristic of most *Xylariae*.



Fig. 33.—Petri-dish culture of *Xylaria*, showing the mycelium and stromatal branches after two and one-half months on acidified potato dextrose agar. The positive phototropic reaction of the stromata during growth is evident.

Abrupt bending of the stalks with their tendency to elongate horizontally, shown in figure 33, is evidence of this reaction. This culture was kept at the far side of a room rather dimly lighted by windows on one side, first in one position and then in the opposite with reference to the source of light, and the striking changes in direction of growth shown in the picture resulted from shifting the position of the culture.

Small ovoid, hyaline, single-celled conidia are borne along the white upper portion of the stromata about ten days after they appear. In our cultures the stromata were generally unbranched, but a few became forked near the tips. Perithecia have not developed, though swellings in the stromata have begun to form.

OTHER FUNGI

Other fungi which have been isolated from diseased elms are *Helminthosporium*, *Rhabdospora* and *Epicoccum*. The first has been

isolated twice and the other two once each. The conidia and sporodochia of *Epicoccum* have been observed to occur frequently upon the bark of elms, and it is not surprising that it should have been obtained in culture. The significance of *Helminthosporium* and *Rhabdospora* has not been determined.

BACTERIA

A little over 8 per cent of the isolation tests made of diseased elms furnished bacterial growths. During the course of the investigations of the dying of elms in Europe, bacteria were encountered by various workers. Brussoff (1925), in particular, isolated a bacterium, which he called *Micrococcus Ulmi*, from trees showing symptoms of wilt and dieback. A considerable controversy resulted, following publication of his report in 1925, as the fungus *Graphium Ulmi* had been described in 1922 by Schwarz as the cause of the same (or a very similar) disease. During the controversy and later, as a result of further research, *Graphium Ulmi* was determined to be the cause of the Dutch elm disease and Brussoff's work received more discredit than was due it. Brussoff's evidence points definitely to the existence of bacterial elm pathogens, and this is further borne out by Buisman's (Westerdijk en Buisman, 1929) description of *Pseudomonas lignicola* as the cause of one elm disease in Holland.

In view of the present incomplete knowledge of elm bacteria, the isolations obtained from diseased trees appear to have a potential importance that exceeds our present results with them.

Bacterial colonies have been obtained in isolation tests for the most part when the summer temperatures were too high for fungus growth—at least, at such times the growth of most of our fungi was very slow, and some ceased growing.

Tests of the pathogenicity of several of the bacterial isolations were made upon elm seedlings grown in the laboratory. Inoculations were made in early July and the inoculated seedlings were kept under observation until late October. Negative results were obtained with all, but the conditions under which the trials were made were by no means ideal and it is not safe to conclude that these organisms are nonpathogenic.

INOCULATION TRIALS

WITH so large a number of fungi isolated from elms, it is readily seen that much study and experimentation with each organism will be necessary before the exact relationship existing between it and the so-called "elm wilt" can be ascertained and its importance definitely established.

As stated before, certain of the fungi that have been obtained are

probably entirely saprophytic, others may be weak parasites capable of injurious attack only after the tree is in a weakened condition, and others must certainly be highly aggressive parasites. The facts can be determined only after thorough inoculation tests of the individual organisms have been made.

During the past summer inoculations were attempted under as near an approach to field conditions as possible. Thirteen of the different fungi which had been secured from diseased elms were tested. For this purpose 1500 young American elms grown from seedling stock were used. The trees, grown out of doors, occupied approximately a quarter of an acre. At the time the first trials were made they were between two and three feet high and quite vigorous. They had been planted in April, in rows about the same distance apart as elms set in the nursery.

Various methods of inoculation were tried. Some of the trees were sprayed thoroughly with suspensions of spores. Other inoculations were made by placing fragments of plate cultures in the axils of unfolding leaves and shoots. Direct inoculation of the stems was also attempted by inserting cultures in incisions made in the bark and in holes bored in the stem. Adequate care was always taken to cover the inoculum against chance contamination and to maintain an abundance of moisture for growth of the fungus. Up to this writing these experiments have given no results. Leaf fall occurred before any external symptoms indicating positive reactions became manifest. It is altogether probable that a rather long period may be required before evidence of the success of the inoculations appears. In some cases another, or perhaps even two more, seasons' growth may be needed before any symptoms of disease become evident, while in other cases the success of inoculation trials may be dependent upon the season of the year in which the trials are made.

PRELIMINARY CONTROL EXPERIMENTS

THE problem of finding a means for controlling these elm diseases is a decidedly complex question, since there are so many separate diseases to be combated. If control measures are developed which are successful against one disease they may not be equally useful against the others. However, some encouragement is to be had from the fact that, at least in nursery stock, the diseases caused by *Coniothyrium* and *Phoma* are of outstanding importance. They are very widely distributed and abundant, and a means for controlling them will greatly reduce the losses of elm stock in nurseries.

During the summer of 1931 two experiments upon the control of elm diseases were undertaken in nurseries. Both experiments were

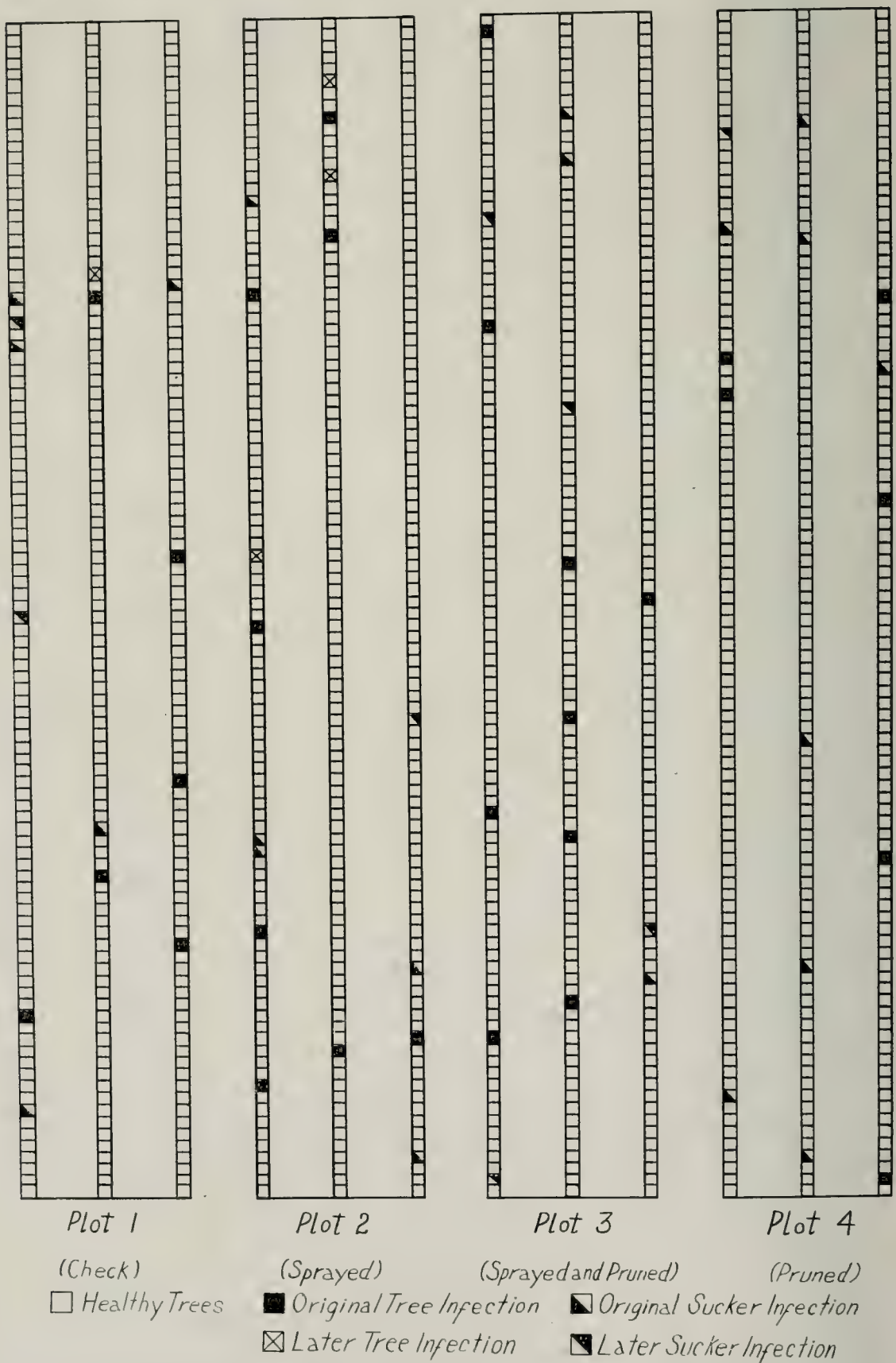


Fig. 34.—Diagram of the nursery plots used in Experiment No. 1. Trees are represented by squares, open squares showing healthy trees, black squares originally-infected trees, and crossed squares trees infected after treatments were begun. Diseased suckers growing from stumps are shown by half black squares, as indicated in the legend.

performed chiefly as preliminary tests which would serve as guides for more intensive ones to follow, though it was, of course, desired to obtain as much information as possible relative to means of combating the various diseases. The two experiments were conducted with the coöperation and aid of the Swain-Nelson nursery and the Freeman nursery, both of which firms willingly and courteously contributed the use of their elm blocks to the experiments, as well as much valuable assistance in other phases of the work.

EXPERIMENT NO. 1

A diagram of the plot of trees used in the experiment conducted at the Swain-Nelson nursery is shown in figure 34. The trees were divided into four plots, each of which included three rows. As each row contained 100 trees, there were 300 in each plot and a total of 1200 trees in the experiment.

Plot 1 served as a check. It received no treatment but indicated the amount of increase in infection taking place during the course of the experiment. The trees in Plot 2 were sprayed with Devoe's standard preparation of commercial Bordeaux mixture, which contains, according to the manufacturers, a metallic copper equivalent of 13 per cent or a copper oxide equivalent of 16.25 per cent. This spray was used in a 3-3-50 concentration. Plot 3 also received a thorough spraying with the same material, and in addition all badly diseased trees, all diseased parts of trees and all dead limbs were pruned out as carefully and completely as possible. In Plot 4 only pruning was practiced, no spray being applied.

This experiment was begun July 29, 1931, and the final observations were made September 21, 1931. During this interval Plots 2 and 3 received two sprays, the first at the beginning of the experiment or August 1, and the other, August 24.

The results obtained from this experiment are inconclusive, due in part to the fact that only a very small number of new infections appeared in the check plot during the course of the experiment and also to the fact that sometime previous to the beginning of the experiment the nursery owners had removed all trees that appeared to them to be diseased. In the rows used for the experiment there was, of course, some difference in the number of diseased trees, but this number was uniformly small, ranging from 6 to 9 per cent, and the possibility of infection coming in from outside sources was not restricted. For a reliable interpretation of results from an experiment such as this, it is desirable to have a fairly large number of new infections occur in the check plot. Most of the infections in these plots previous to treatment were in the form of diseased shoots or suckers arising from the bases of diseased trees which previously had been cut down.

Results of the experiment are presented in table V, which shows the per cent of increase of disease above that originally present in each plot.

TABLE V.—INCREASE IN INFECTION AFTER TREATMENT IN EXPERIMENT NO. 1.

Plot Number	Treatment	Number of original infections	Number of new infections	Per cent of increase in disease
1	None (Check)	6	1	16.6
2	Sprayed	8	3	37.5
3	Sprayed and pruned	9	0	0
4	Pruned	6	0	0

These results seem to indicate that spraying with Bordeaux mixture alone, at least at the times and with the strength used, is ineffective. More new infections occurred in the sprayed than in the check plot. Pruning and spraying combined seemed to be completely effective in preventing the occurrence of new cases of disease, but the same effectiveness is indicated when pruning alone was practiced.

Diseased shoots arising from stumps left after removal of diseased trees were not recorded in this experiment as new infections. Such shoots are not new cases but become diseased by growth into them of the disease from the stumps from which they arise. It has been observed, also, that if the diseased trees are cut off a considerable distance below the advancing infection in the trunk, the new basal shoots often continue healthy.

The conclusions to be drawn from this experiment are first, that spraying with commercial Bordeaux mixture in a 3-3-50 dilution is not injurious to nursery elm stock; second, that Bordeaux applied in that strength in mid and late summer is not treatment sufficient to prevent occurrence of a considerable percentage of new infections; and third, that pruning alone and pruning and spraying combined are apparently effective in preventing any considerable increase in the amount of disease.

It must be understood, however, that the results of this test can be applied only where disease is relatively scarce. In badly diseased elm blocks the indications are entirely different, as the second experiment shows.

EXPERIMENT NO. 2

The second experiment in controlling "elm wilt" was conducted at the Freeman nursery. A diagram of the trees used in this experiment is shown in figure 35. The trees were divided, as in the first experiment, into four plots of three rows each. There were 50 trees in each row, making a total of 150 trees in each plot and 600 trees in the entire experiment.

The treatments employed were the same as in the first experiment, and the arrangement of the treatments by plots was as follows: Plot 1 was subjected to pruning, Plot 2 was pruned and sprayed, Plot 3 was sprayed, and Plot 4 served as a check. Pruning and spraying were done in the same way as the first experiment, the spray used being also a 3-3-50 concentration of Devoe's commercial Bordeaux mixture. The experiment was begun August 3, 1931, and final observations were made September 22, 1931. Plots 2 and 3 were sprayed August 5 and again August 25. The results obtained are given in table VI.

TABLE VI.—INCREASE IN INFECTION AFTER TREATMENT IN EXPERIMENT NO. 2.

Plot Number	Treatment	Number of original infections	Number of new infections	Per cent of increase in disease
1	Pruned	5	3	60.0
2	Pruned and sprayed	25	9	36.0
3	Sprayed	27	7	25.9
4	None (Check)	17	13	76.4

As should be expected, the greatest increase in infection occurred in the check plot. The next greatest increase was in Plot 1, which had been treated by pruning. The occurrence of three new cases of disease in addition to the five originally present shows the increase to be 60 per cent, but this is 16 per cent less than that occurring in the check plot. Although a certain degree of control over the appearance of new cases is indicated, as was true in the first experiment, the small number of trees originally diseased, together with the large increase in disease, throws doubt upon the dependability of the treatment. The apparently beneficial effect of pruning might be due entirely to elimination of the source of infectious material within the plot itself.

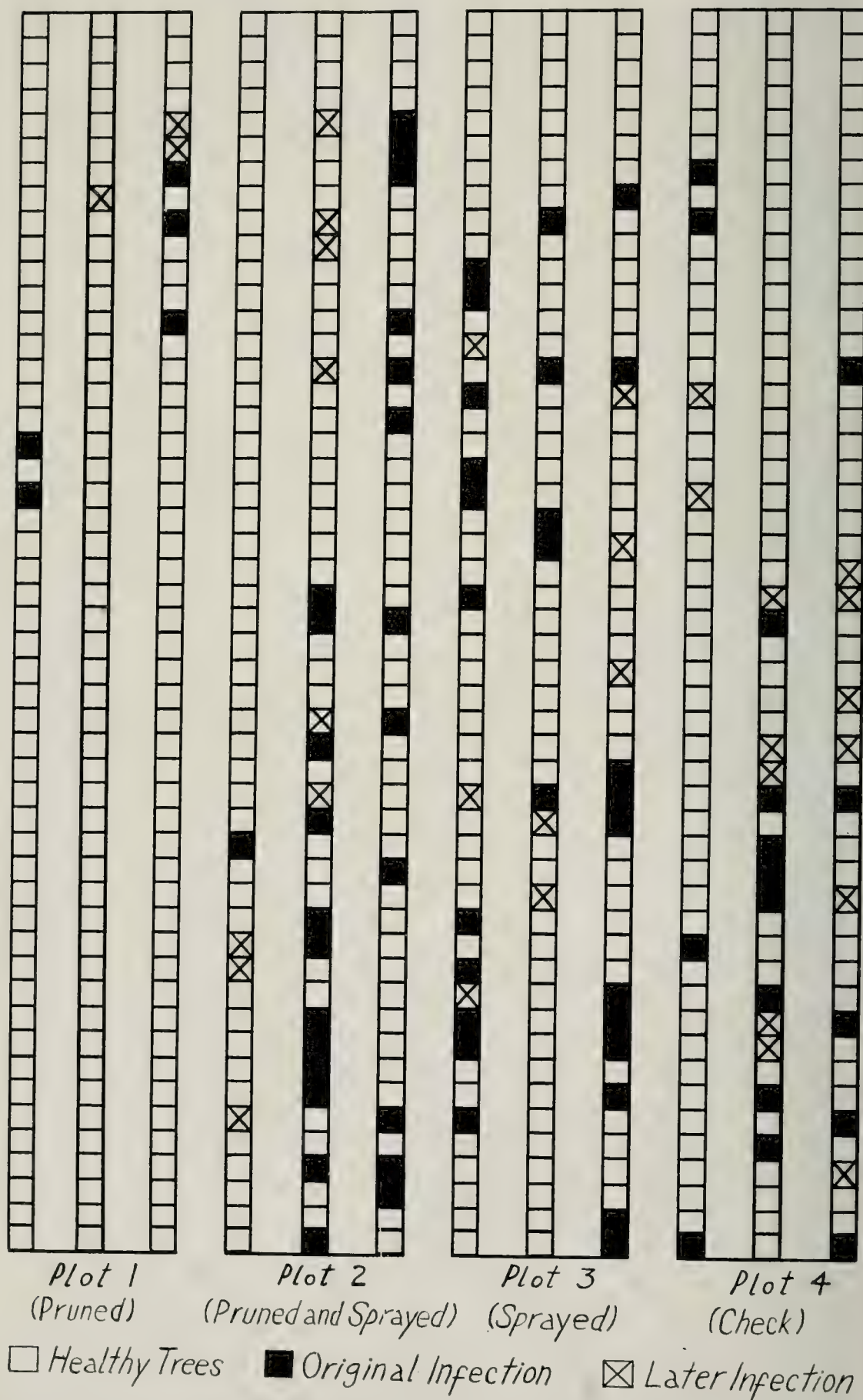


Fig. 35.—Diagram of the nursery plots used in Experiment No. 2. Trees are represented by squares, open squares showing healthy trees, black squares trees diseased before, and crossed squares trees diseased subsequent to the beginning of treatment.

The fact that under conditions of heavy infection the lowest percentages of new cases of disease occurred in the plots treated by spraying, or by spraying and pruning, affords hope that the most satisfactory control may be developed along this line. A more thorough experimentation with spraying appears especially justifiable, since increase in number of diseased trees was 50 per cent less in the plot treated by spraying alone than it was in the check, while in the pruned and sprayed plot the increase was only about 40 per cent of that in the check.

RELATION TO THE PROBLEM OF CONTROL

An important fact to be considered in connection with the results of these two experiments is the concentration of Bordeaux mixture used. The 3-3-50 concentration was employed, not because it was thought to be strong enough to afford maximum, or even satisfactory, protection but because no one knew definitely what concentration elm foliage could endure without injury. The trees employed in the experiments were of considerable commercial value to their owners. In the experiments, however, no elm suffered any injury from the spray, and we are therefore assured that a more strongly fungicidal concentration could be used without endangering the trees.

These experiments have been concerned with preventing occurrence of new cases of disease rather than with curing trees after they have become diseased. The facts concerning effect, probable time and place of infection, and spread of infection presented, especially in connection with the important *Coniothyrium* disease of nursery elm stock, seem to show that attempts to cure sick trees are not likely to meet with satisfactory success, especially since trimming out, or amputating, diseased parts is the only curative measure that can be applied. It is, of course, obvious that if diseased parts of trees could be cut out so as certainly to remove all internal infection and at the same time leave the tree in salable condition from the nurserymen's point of view, the problem of control would be solved, except for the great cost of doing the work. But there is no indication at the present time that trimming performed by ordinary workmen can be depended upon to accomplish that result. There is, also, the obvious possibility of removing diseased trees from nursery blocks. This, of course, will destroy infection present at the time the removal is performed, but the healthy trees left in the blocks still remain exposed to infection from outside sources, and year by year a varying proportion of these trees will become diseased and have to be removed. The cumulative effect of the process will be a gradual but certain demolition of the elm block and a consequent loss to the nurseryman, which will depend upon the age at which he is able to sell his trees.

Trimming, and its possible effectiveness, needs further detailed

study before it can be recommended. The nurseryman will recognize that its use, together with the immediate removal and destruction of badly diseased trees, is a protective measure which, if taken, will eliminate many sources of infection in the elm block itself. But, in addition, protection must be secured against the introduction of infection from outside sources, and it is this at which a spraying program is aimed.

Once the disease establishes itself within a tree, no amount of spraying or other kind of treatment now known will afford a cure. A claim has been made by a European pharmacist (Anonymous, 1931) that a remedy has been discovered which will cure elm trees even after they have become badly diseased. The injection of this remedy into the roots, its subsequent absorption by the root system and conduction into affected parts of the tree supposedly effects the cure. It is very doubtful whether practical results can be had from the use of this treatment. May and Liming (1931) state that in no instance have carefully controlled experiments shown any of these injected substances to be of value.

Beneficial effects may be secured by pruning, provided all infection is removed. In the experimental work this was indicated by the fact that a further progress of disease was not observed, up to the time when our final check was made, in any trees treated by pruning. Proof of this must depend, however, upon what happens during another season's growth, as it has been found in other trees treated by pruning that unless complete removal of the infection is accomplished the disease will continue through the tree and eventually kill it. Mere removal of all external manifestations of disease is not sufficient. In the case of the *Coniothyrium* disease, actual infection in the interior of the wood is known to extend an indeterminate distance below the lower limits of the externally visible cankers, *and even beyond visible wood discoloration*. Pruning is to be recommended, therefore, only when the number of diseased trees is so small that it can be done effectively at low cost.

Cleanliness in the nursery cannot be disregarded as a practical step in lessening the number of sources of infection and the amount of infectious material.

The crowded condition which commonly prevails in nursery elm blocks probably influences the prevalence and severity of disease. The moist environment created by closely planted trees favors fungous growth and probably spore production, but since it is usually the top parts of the trees which first become affected, it is evident that exposure to sunlight and free circulation of air are necessary for infection.

Some varieties of the American elm are evidently more resistant to disease than others. No experimental work has been done in this connection but our observations in nurseries where the Moline and Vase elms are cultivated show that these varieties are always quite free from disease. That these varieties may be attacked by fungous parasites is evident, however, from the fact that we have isolated a *Vermicularia* from a Moline elm.

SUMMARY

RESULTS of the present investigations concerning the nature of the elm malady in Illinois show, primarily, that the so-called "elm wilt" is not a single disease but is in reality several different diseases. These diseases manifest themselves in a number of forms, such as twig blights, cankers, diebacks and true wilts. They are statewide in distribution and occur in nursery, parkway and lawn trees. During the past few years thousands of elms have been lost in nurseries and many valuable trees standing in cities have been killed.

Most important of these diseases in Illinois is one that appears to be caused by *Coniothyrium*. It manifests itself outwardly as a twig blight and canker and internally as a mycosis of the water conducting tissues. Other important diseases are caused by *Phoma*, *Sphaeropsis*, *Vermicularia* and *Verticillium*.

The Dutch elm disease has never been found in Illinois, though the other diseases have been popularly mistaken for it.

Nearly 200 diseased trees have received laboratory examinations during the course of the investigation and over 500 isolations of fungi have been secured, among which are 20 genera and about 30 species. The pathogenicity of these various fungi is as yet not completely determined, though infection experiments are progressing at the present time.

The problem of controlling these diseases will prove complex, since several diseases, rather than one, have to be considered. In preliminary experiments conducted in nurseries, Bordeaux mixture has given encouraging results, and pruning when carefully practiced has proved valuable also.

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STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
NATURAL HISTORY SURVEY
THEODORE H. FRISON, *Chief*

Vol. XX

BULLETIN

Article II

A Survey of the Fishery of the Kaskaskia River

WILBUR M. LUCE



PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
AUGUST 1933

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STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
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CONTENTS

	PAGE
INTRODUCTION	71
HYDROGRAPHY	74
PERSONNEL	80
METHODS AND EQUIPMENT.....	80
THE VALUE OF THE FISHERY.....	83
KINDS AND NUMBERS OF MUSSELS.....	86
KINDS OF FISHES CAUGHT WITH VARIOUS TACKLE.....	87
FACTORS AFFECTING THE ABUNDANCE OF FISHES	
IN THE KASKASKIA.....	89
THE RATE OF GROWTH IN FISHES.....	93
THE FISHES OF THE KASKASKIA.....	94
Large Fishes.....	95
Small Fishes.....	114
LITERATURE CITED.....	121

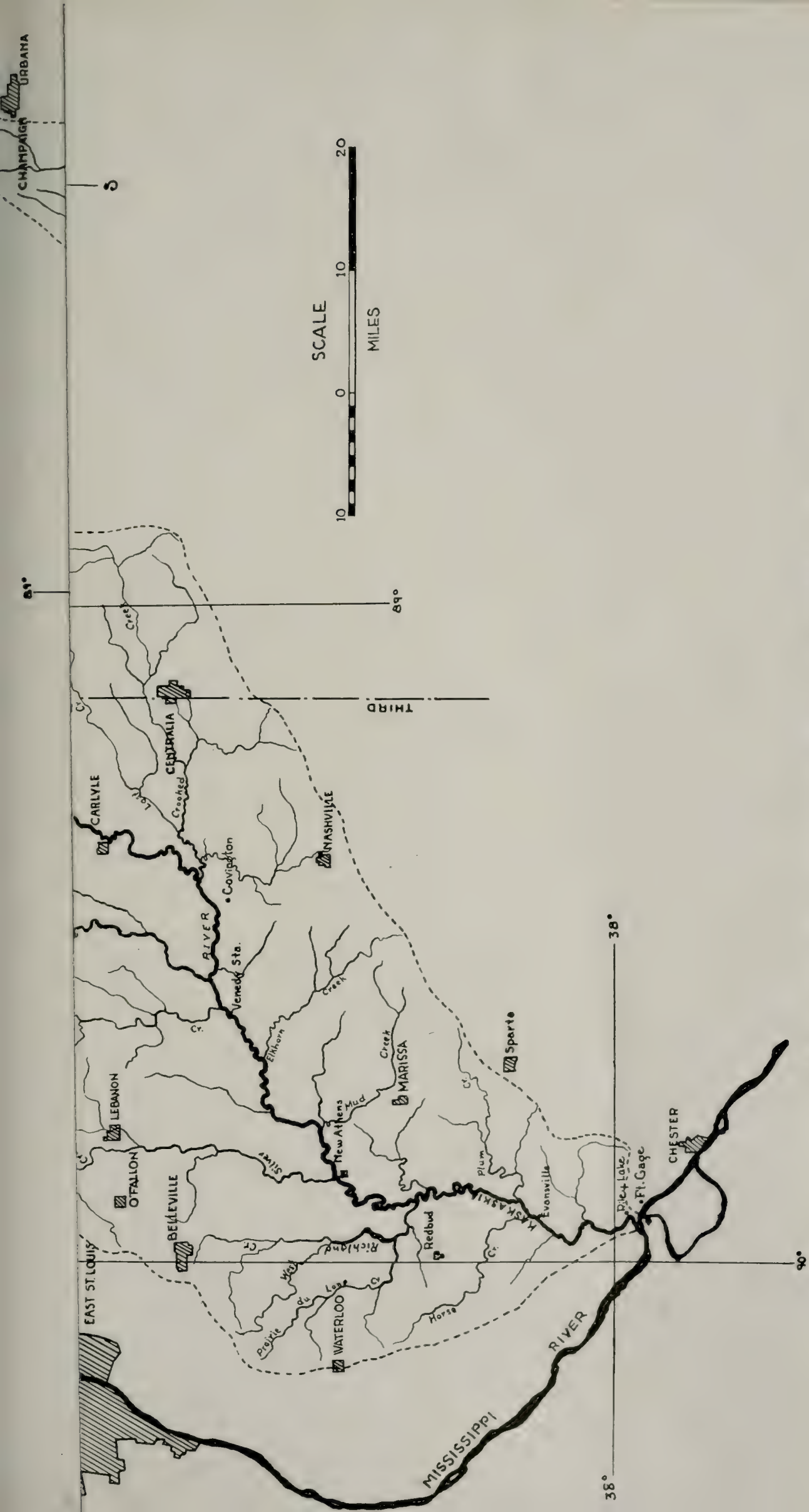


Fig. 1.—Sketch map of the drainage basin of the Kaskaskia River.

STATE OF ILLINOIS
DIVISION OF
NATURAL HISTORY SURVEY
1930
KASKASKIA RIVER BASIN



Fig. 1.—Sketch map of the drainage basin of the Kaskaskia River.

A Survey of the Fishery of the Kaskaskia River

WILBUR M. LUCE

INTRODUCTION

IN the smaller streams and rivers of Illinois the principal value of the fishes and other aquatic products is attached to hook and line fishing and to the recreation and sport of taking fishes, with secondary importance attending commercial fishing. The Kaskaskia, or Okaw, River¹ is a fair representative of the secondary streams of Illinois. In this survey we have determined what kinds of fishes are present. A comparison with the collections of fishes made in this stream 30 or more years ago by the late Professor S. A. Forbes and his associates shows that there has been very little alteration in the variety of kinds present.

Statistics gathered by the United States Bureau of Fisheries for 1922 (Sette, 1925)² on the commercial fishery of the Kaskaskia present to the hook and line fisherman a very imperfect picture of the kinds and abundances of fishes in this stream. Accordingly, special efforts were made in this survey to collect those kinds which are most attractive to the sportsman, and to form some conception of their sizes and relative abundances, with any additional information readily obtained concerning their life history, growth or other features of their welfare.

An attempt has been made to analyze the effect of some of the more obvious environmental factors and conditions which are known to affect the distribution and abundance of fishes. The Kaskaskia River is one of the cleaner streams of Illinois and there is little reason to believe that pollution has made any extensive inroads on the fish yield. However, at intermittent periods and at certain places, pollutorial conditions do exist which either destroy fishes or force them to abandon certain regions, and destroy a large part of their food resources over wide areas.

1. See map facing this page.

2. References are to literature citations, page 121, following.

In the course of this survey, 587 of the more important fishes were tagged and released in order to learn whether or not any considerable migrations take place among these useful kinds. While no extremely large migrations have come to our notice from fishes tagged in the Kaskaskia or any other Illinois waters, we were surprised to learn that the catfishes, and in particular the black bullhead, make rather extensive migrations covering distances 10, 20 or even 40 miles upstream within a few days or



Fig. 2.—Kaskaskia River near Bondville, October, 1929.

weeks. Migrations of a similar order but somewhat smaller have been found to prevail among others of our more common fishes either in the Kaskaskia or in other waters of the state. This fact leads us to believe that following such catastrophes as pollution, extreme drouth or other conditions which may drive the fishes out of wide areas, the reestablishment of suitable conditions is followed by rapid recovery. Within a year sufficient breeding stock will have entered the area as migrants and within two or three years the fish population will have assumed its normal aspects. This is of considerable consequence as a practical matter of conservation since it shows that restocking of our waters by such natural means goes on rapidly and under ordinary conditions makes artificial propagation and distribution of fishes in these waters unnecessary. No evidence has come to light in this survey which indicates that the fish population of the Kaskaskia is in any sense seriously depleted, that the river is overfished, or that any of the ordinary popular remedies will be reflected by increases in fish yield.

At various times in the past decade or two considerable portions of the Kaskaskia have been open to commercial fishing. At present the entire river is closed and fishes may be taken legally only with hook and line. Indeed, it seems that the Kaskaskia as a whole is most useful as a place in which to fish with hook and line, except for the lowermost part of its course from Evansville to the mouth in Randolph county. There the stream has a width and depth not found in its upper reaches and fishes typical of the main channel of the Mississippi are found in great numbers.

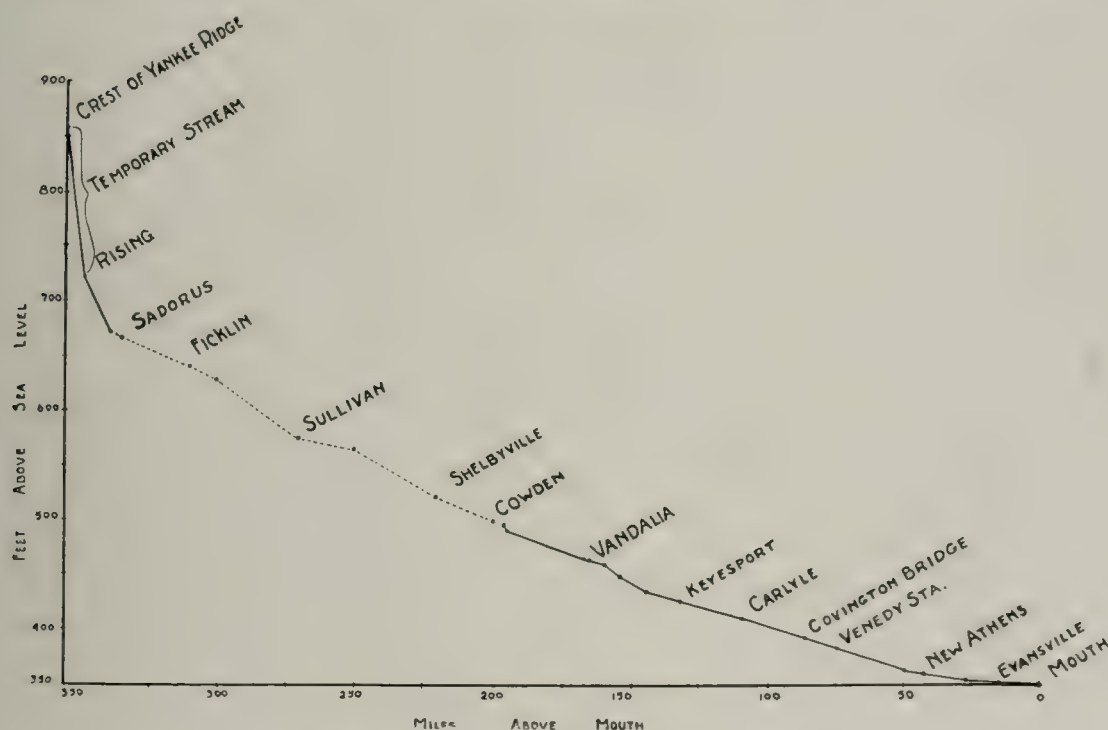


Fig. 3.—Profile of the Kaskaskia River.

Spoonbill cat, channel cat, bullheads, the huge flathead cat and Fulton cat are numerous, together with still greater numbers of carp and buffalo. All of these are commercial fishes and are seldom or irregularly taken on hook and line. It is commonly known that many commercial fishes of the Mississippi River proper retreat into the mouth of the Kaskaskia during the winter months and move out again in spring.

In this paper the fishes of the Kaskaskia have been taken up one by one and in the case of the larger and better known kinds points of interest and usefulness have been discussed, while the smaller, rarer and less important kinds are only mentioned. In the course of this survey quantitative collections were made of the small bottom animals which are the most important constituents of the food of all kinds of larger fishes. Detailed analyses of this material and data will be presented in a later report. Material was also collected for determining the rate of growth of all the more important kinds of fishes, but this, too, can be presented more

effectively when material from other parts of the state is brought into comparison. It may be mentioned here that such a study of the rate of growth of the white crappie is being completed. Comparison of the total lengths in inches of white crappies for different ages in the Kaskaskia and Sangamon rivers is shown in the following tabulation.

WHITE CRAPPIE

RIVER	AVERAGE LENGTH IN INCHES AT			
	1 yr.	2 yrs.	3 yrs.	4 yrs.
Kaskaskia.....	3.2	5.2	6.2	6.7
Sangamon.....	3.2	5.3	5.8	6.4

HYDROGRAPHY

THE Kaskaskia River has its source on the southwestern slope of Yankee Ridge in Champaign county, about 2 miles northeast of the town of Rising, 6 miles northwest of Champaign-Urbana and about 40 miles west of the Indiana state line. The ravine which forms the source extends down the slope of a hill, the top of which is the highest point in Champaign county, 860 feet above sea level.

The river flows in a general southwest direction, diagonally across the state, and empties into the Mississippi River about 7 miles above the town of Chester in Randolph county. Elevation at the mouth is about 350 feet above mean sea level when the Mississippi is at an ordinary stage of water. The straight line distance from source to mouth is 180 miles, but the river is very crooked throughout the greater part of its course, except for the upper 20 miles which have been dredged and straightened. Its actual length is more than 350 miles. The width of the river is 40-60 feet in Moultrie country, 120-150 feet in Clinton and Washington counties, 150-250 feet in St. Clair county and 250-500 feet in Randolph county.

As one would expect from the winding character of its channel, the river has a slight fall throughout most of its length. On the profile shown in Fig. 3, data for the elevations from Cowden to the mouth were taken from maps based on a survey made in 1908 by the United States Department of Agriculture in coöperation with the Illinois State Geological Survey and the United States Geological Survey, data for elevations from the source to the edge of the Mahomet quadrangle just above Sadorus were taken from the contour elevations of that quadrangle, and those for

that part of the profile represented by dotted lines were calculated from the railroad elevations on the base map of Illinois prepared by the Illinois State Geological Survey in coöperation with the United States Geological Survey. If we consider the top of Yankee Ridge as our starting point, the stream drops 140 feet during the first 2 miles of its course. Where it leaves the Mahomet quadrangle, at a point about 12 miles from its source, its elevation is about 670 feet—a fall of about 190 feet from the highest point in the headwaters. From this point to the mouth of the river the fall

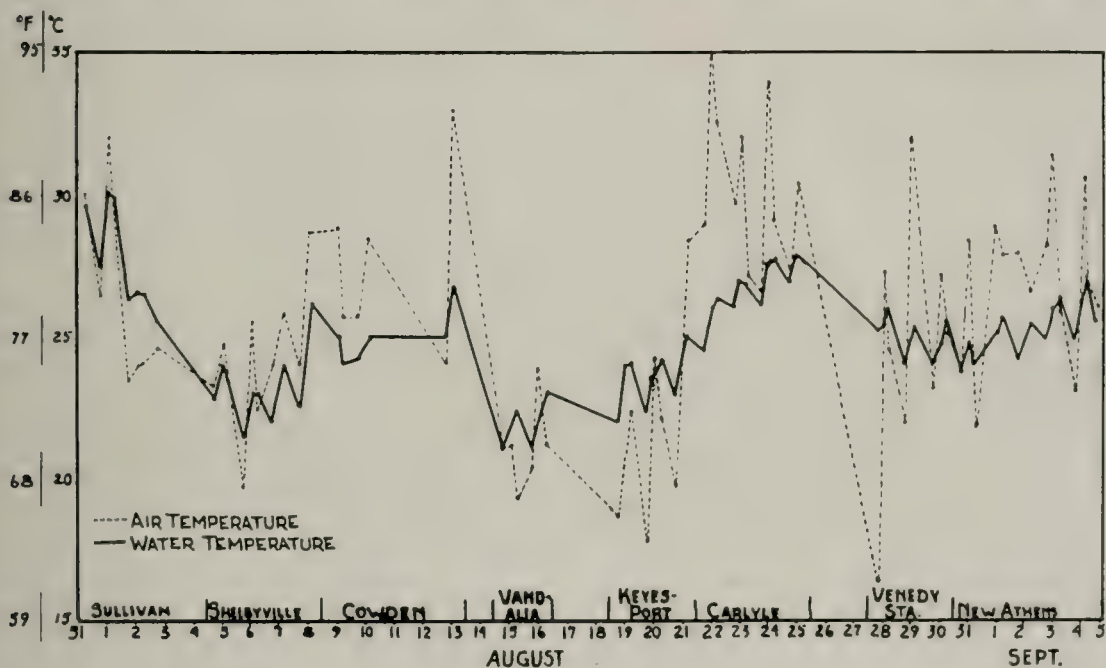


Fig. 4.—Air and water temperatures on the Kaskaskia in the summer of 1929.

is much less, varying from a maximum of 55 feet in 18 miles through Moultrie county to the low gradient found in St. Clair county where the fall is only 10 feet in 20 miles.

As a result of the stream's very low gradient and winding character, its rate of flow is quite slow after emerging from the Shelbyville moraine. Above Shelbyville, at least during periods of comparatively low water, there are stretches of quiet pools and riffles alternating with comparatively swift water, but below this point the stretches of rapid water occur less often and the stream has a slower and more nearly uniform flow.

The graphs in Fig. 4 show the temperatures recorded while the field party was working on the Kaskaskia during the summer of 1929. The water temperatures were taken about 2 inches below the surface, well out in the channel of the river. The air temperatures were taken in the shade. The same thermometer was used for both. As one would expect, the graphs show that there is less variation in the water than in the air. Thus the water ranged from 69.8° to 86° F. while the air ranged from 61° to

95° F. The general trend is the same in both, and variations in the water are always in the same direction as, and doubtless a direct result of, variations in the air.

The water of the river is usually quite turbid, the color of the suspended matter depending upon the nature of the soil. Above Shelbyville, where the river is draining the darker soils of the Wisconsin glaciation, the water is grayish brown when turbid; below this point, where drainage is from Illinoisan glaciation, the color is brownish yellow.



Fig. 5.—Kaskaskia River at Vandalia, July, 1930.

The bottom of the river is not worn down to bedrock except for about 20 miles near Shelbyville, where the bed is limestone. Throughout the first 10 miles from its source the stream has been dredged and the bottom is muddy, with little sand and gravel and with considerable aquatic vegetation. For the rest of the river's length the bottom is primarily sand and gravel with very little mud, and is almost devoid of aquatic and shore-line vegetation. Wherever riffles occur in Douglas, Coles, Moultrie and Shelby counties, the bottom is composed of coarse pebbles and glacial boulders of various sizes. Through St. Clair and Randolph counties during periods of low water the bottom is often covered with a layer of fine silt as much as a foot deep, which overlays a bed of hard packed sand and gravel and which is frequently scoured away during periods of flood.

In Champaign and Douglas counties the river has developed no extensive valley, and its bed is not much lower than the surrounding plain.

Through Moultrie and Shelby counties the valley varies in width from 1/8 mile to 11½ miles, the topography being rather rough throughout this region. Where the river emerges from the Shelbyville moraine its valley widens to about 3 miles. This width is maintained as far as New Athens in St. Clair county, except at Carlyle in Clinton county where the valley narrows to about 1 mile for a short distance. From New Athens to the mouth the valley has an average width of 1 mile.

TABLE I.—MONTHLY DISCHARGE OF THE KASKASKIA RIVER AT VANDALIA. DRAIN-
AGE AREA 1,980 SQUARE MILES.

YEAR	MONTH OF MAXIMUM	MONTH OF MINIMUM	DISCHARGE IN SECOND-FEET				RUN-OFF IN INCHES
			Max.	Min.	Mean	Per square mile	
1908	May	Sept.	7,720	12	....	....	....
1909	Apr.	Jan.	7,570	29	1,650	.834	11.25
1910	Mar.	Nov.	6,970	59	1,240	.626	8.52
1911	Oct.	Aug.	13,000	3.5	1,740	.879	11.96
1912	Mar.	{Nov. Dec.}	7,210	62	.....	....	.....
1913		Gage 21.7 feet March 29, 1913					
1915	May	Oct.	14,800	43	1,390	.702	9.53
1916	Jan.	Sept.	14,400	19	1,340	.677	9.20
1917	June	{Oct. Nov.}	11,100	19	1,000	.505	6.88
1918	May	Oct.	8,460	38	1,150	.581	7.92
1919	Mar.	Sept.	11,000	37	1,350	.682	9.28
1920	May	Oct.	12,200	36	1,790	.904	12.31
1921	Sept.	{Oct. Nov.}	2,920	43	New bridge put in		
1922	Apr.	Sept.	18,800	19	2,300	1.16	15.72
1923	Mar.	Oct.	13,700	18	870	.439	5.94
1924	Dec.	Aug.	10,500	78	1,680	.848	11.59
1925	Mar.	Sept.	9,500	35	960	.485	6.95
1926	Sept.	Oct.	8,460	37	1,220	.616	8.36

The drainage basin of the Kaskaskia, or Okaw, is long and narrow, extending northeast to southwest for 180 miles, with an average width of 30 miles, a maximum width of 55 miles and an area of 5,670 square miles. The upper third lies in the Wisconsin glacial drift and the lower two-thirds in the Illinoisan.

Most of that part of the basin which is made up of the Wisconsin glacial till is drained by tiles, the soils here consisting predominantly of brown silt loam and black clay loam, with a rather loosely packed subsoil

that makes tile laying economically possible. Artificial drainage increases the rapidity of the run-off. In the greater part of the basin, which consists of Illinoisan and earlier drifts, the soil is made up of loams, silts and loess. Here the subsoil is a compact clay, which condition also results in a very quick run-off. Consequently the river is subject to large and rapid varia-

TABLE II.—MONTHLY DISCHARGE OF THE KASKASKIA RIVER AT NEW ATHENS. DRAINAGE AREA 5,220 SQUARE MILES.

YEAR	MONTH OF MAXIMUM	MONTH OF MINIMUM	DISCHARGE IN SECOND-FEET				RUN-OFF IN INCHES
			Max.	Min.	Mean	Per square mile	
1907	Jan.	Oct.	20,300	663	5,160	.989	13.52
1908	May	Nov.	31,700	264	7,380	1.41	19.20
1909	Apr.	Jan.	17,800	450	5,830	1.12	15.07
1910	Mar.	Nov.	27,000	344	4,590	.879	11.93
1911	May	Aug.	25,500	162	4,180	.801	10.87
1912	Apr.	Dec.	37,200	198	.....	.....	.....
1913	.....	Gage 32.9 feet March 30, 1913					
1915	Aug.	Oct.	63,100	133	6,020	1.15	15.64
1916	Feb.	Sept.	54,800	185	5,310	1.02	13.83
1917	June	Oct.	26,100	142	2,900	.556	7.55
1918	Apr.	Nov.	20,300	107	2,790	.534	7.29
1919	Mar.	Sept.	12,700	162	2,930	.561	7.62
1920	Nov.	Oct.	28,000	175	5,030	.964	13.09
1921	Apr.	Nov.	13,300	130	1,700	.326	4.39

tions in level and volume of water discharged. These differences are indicated in Tables I and II, showing the discharge in cubic feet per second at Vandalia and New Athens as compiled by the United States Geological Survey.

The bottomlands of the river valley are in general 10 to 20 feet above the usual stage of water. The banks of the river, which are usually steep, are muddy as far downstream as Sullivan, below which they become more sandy. In spite of the high banks of the river the valley is subject to serious floods from time to time, and for this reason the bottomlands of the lower Kaskaskia are not cultivated extensively except in Fayette county near Vandalia. Even in this area the drainage of the bottomlands has not been very successful and much of the land is still in timber.

During the summer of 1929 the mouth of the river was filled with a delta of soft mud, so that water coming out of the Kaskaskia was distributed among numerous wide shallow channels which were difficult if not impos-

sible of passage, even by rowboat. In the spring of 1930 a flood washed out this muddy delta.

The floodplain of the Kaskaskia, after the river has emerged from the Shelbyville moraine, is dotted with small overflow lakes and sloughs. These are especially numerous through Bond, Clinton, Washington and St. Clair counties. None of them are extensive in area and their total combined area is not large.



Fig. 6.—Kaskaskia River at Carlyle, July, 1930.

In the lower Kaskaskia basin there are numerous ponds on the surrounding high lands. Individually, these are usually less than an acre in extent but many are permanent, as they contained water throughout the very dry summer of 1930.

The main tributaries of the Kaskaskia are Richland, Silver and Shoal creeks to the westward, and Crooked Creek to the eastward. Other than these, there are numerous smaller tributary creeks, Fig. 1.

Perhaps one of the most interesting facts in connection with the hydrography of the Kaskaskia is the stealing of the lower part of the Kaskaskia valley by the Mississippi. The old mouth of the Kaskaskia was near the town of Chester, at the southern end of what is now Kaskaskia Island, about 7 miles below the present mouth of the river. On April 18, 1881, the Mississippi broke through the neck of land at the bend 2 miles above the old town of Kaskaskia. There was at this point a difference of 8 feet in the level of the two rivers, the Kaskaskia being the lower. The result was that the diverted water of the Mississippi soon cut a channel into the Kaskaskia

and appropriated the lower 7 miles of its bed. This new channel was originally but 500 to 600 feet wide, so that at first it carried only a small part of the volume of the Mississippi. Gradually the new channel became widened and deepened until finally the old channel filled up, and at times of low water it is now possible to walk dry-shod from Missouri to Kaskaskia Island. Since the east bank of the Kaskaskia consists of the limestone cliffs that form the bluffs of the Mississippi valley, in widening the new channel the river cut away the softer alluvial west bank and approached the site of the historic town of Kaskaskia. This town had been settled about the year 1700 and had played an important part in the early history of Illinois, as it was the first capital of the state. The town was not destroyed immediately, but the Mississippi in widening its new channel cut away the soil so that Kaskaskia's buildings and improvements gradually disappeared in the bed of the river during the years 1886-1909. Only a small corner of the original town site now remains.

PERSONNEL

FIELD work on the Kaskaskia was done mainly during the summers of 1928 and 1929 and early in the spring of 1930. During the summer of 1928 Dr. David H. Thompson and Mr. Francis D. Hunt made a study of the headwaters of the Kaskaskia as part of the field work for a report on the fishes of Champaign county. During the summer of 1929 Dr. Willard F. Stanley and the writer conducted field studies on the Kaskaskia from Sullivan to the mouth of the river. In the early spring of 1930 Mr. Hunt made further field observations near the mouth of the river. Occasional observations were made at various points during the summer of 1930 by several staff members. Identification of the minnow collections was made by Mr. Hunt and checked by Mr. R. E. Richardson. The plankton identifications and estimates were made by Dr. Samuel Eddy. The entire project has been under the close supervision of Dr. Thompson and any value which it may have is largely due to his guidance. The study was begun under the general supervision of the late Professor S. A. Forbes, formerly chief of the STATE NATURAL HISTORY SURVEY, and has been continued under Dr. T. H. Frison, his successor.

METHODS AND EQUIPMENT

THE general plan of the field work in the summer of 1929 was to make collections and observations at intervals of 10 to 20 miles throughout the course of the river. Temporary headquarters were established for periods of three to five days at each of the following places: Sullivan, Shelbyville, Cowden, Vandalia, Keyesport, Carlyle, Venedy Station, New Athens and Reilly Lake.

For transportation the field party used a half-ton truck with a trailer carrying a 16-foot flat-bottomed skiff. Where depth of the water allowed, an outboard motor was used to propel the boat, but elsewhere oars were used because the stage of water was so low and there were so many bars and snags in the river that the outboard motor was of little use. The field party carried the following equipment: a canvas tent, 6×8 feet; three 30-inch, 1-inch-mesh hoop nets with 5-foot wings; a "common sense" minnow



Fig. 7.—Kaskaskia River at New Athens, July, 1930.

seine, 1/6-inch mesh, 4×12 feet; a 1-inch-mesh trammel net, 6×75 feet; a bottom-sampling outfit consisting of a Peterson dredge, a circular sieve (12 inches in diameter, with 40 meshes to the inch) and a water-tight wooden box (20 inches square and 3 inches deep); a 14-quart galvanized iron pail; a galvanized iron washtub; a plankton-sampling outfit consisting of a piece of No. 20 silk bolting cloth, a 1-liter dipper and a glass funnel; an aquatic dip net with 5-foot handle; two 250-foot trot-lines with 100 snells and 3/0 hooks; a thermometer in a wooden case; a dairy balance with dial graduated to tenths of a pound; a fish measuring board attached to the balance; Monel metal fish tags, sizes 2 and 3, each bearing a serial number on one side and the initials INHS on the other; tongs for affixing the tags; a supply of bottles and jars of assorted sizes, together with labels, alcohol and formalin; and a leather notebook filled with 5×8-inch cards bearing serial accession numbers.

The general procedure of work at each place was as follows. As soon

as a suitable place was found on the river bank, the equipment was unloaded, the tent pitched, the boat launched and the hoop nets set in likely situations, since the main object was to catch as many fishes as possible. Temperature of water and air were taken and recorded three times daily. The hoop nets were raised twice daily and the fishes removed from them into a tub of water and taken to the bank where the weighing and measuring apparatus was set up. Each kind of fish, its length from tip of snout to base of caudal fin and its weight to the nearest twentieth of a pound were recorded in the notebook, together with length of time the net had been set, date and description of environmental conditions. About ten scales were taken from the left side between the lateral line and the dorsal fin of each of the scaled fishes and were placed in a small manila envelope. On the outside of the envelope were recorded the notebook accession number, the tag number, the name of the stream, the location, date, kind of fish, its length and weight. The fish was then tagged near the base of the caudal fin, on the dorsal edge, and returned to the stream. The catching, measuring and tagging of the fishes taken in the hoop nets consumed the greater part of the time at each stop along the river. A record was also kept of turtles and other animals in the hoop nets.

Since certain kinds of fishes avoid small-meshed hoop nets, other methods were also employed. A trammel net was occasionally dragged as a seine, or set and the fishes driven into it. On account of the number of snags and other obstructions in the Kaskaskia, its use as a seine was not satisfactory, few fishes being caught. Trot-lines were also set across stream, with about 50 hooks to the line. Crayfish, minnows or soaked corn were used for bait. The trot-lines were quite satisfactory for catching carp, which avoid hoop nets of small mesh during periods of clear water. Some catfish were also caught by this method. Samples of small fishes were taken with a minnow seine, dragged over an estimated area of 15 square yards to each haul. The entire sample was killed in formalin, transferred to a cheesecloth sack, labeled and stored in a keg of formalin. Identification of the minnows was made later in the laboratory.

Samples of the bottom fauna were taken in as many different kinds of bottom as could be found in each vicinity. A Petersen dredge was used for taking samples in mud, gravel and sand bottoms. Where the bottom consisted of pebbles or rocks and the dredge could not be used, the organisms were rinsed and picked off the rocks by hand. The samples were preserved and sent to the laboratory for identification.

A plankton sample was taken at each stop along the river by straining 20 liters of water from midstream through No. 20 silk bolting cloth. These collections were preserved in 80 per cent alcohol and examined later in the laboratory.

A sample of the fresh-water mussels was taken at each place visited. These usually were taken by hand, as all other methods were found to be unsatisfactory, and the shells were preserved and taken to the laboratory for identification.

THE VALUE OF THE FISHERY

PRINCIPAL sources of information on the fishery of the Kaskaskia, or Okaw, River are the survey made by Forbes and Richardson for "The Fishes of Illinois," published in 1909; a local survey near Charleston, Illinois, made by Hankinson (1913); statistics compiled by the United States Bureau of Fisheries (Sette, 1925); and a detailed study of the distribution and abundance of fishes in Champaign county (Thompson and Hunt 1930). The first two of these sources show the kinds of fishes found in the Kaskaskia and give notes on their habitat relationships, life cycles and general abundance, but afford little information for a comparison with other streams of the state from the standpoint of fish yield. The statistics of the United States Bureau of Fisheries show the value of the commercial fishery supported by each stream system. The latest statistics, those for the year 1922, indicate in a general way the relative importance of the main rivers of the state as follows.

RIVER	VALUE OF MUSSEL SHELLS, PEARLS AND SLUGS	VALUE OF FISH, TURTLES AND FROGS
Illinois.....	\$ 8,524	\$542,489
Mississippi.....	12,806	199,768
Rock.....	109,820	.....
Ohio.....	36,195	38,930
Wabash.....	21,843	34,846
Fox.....	24,794	.....
Kankakee.....	23,320	.....
<i>Kaskaskia</i>	2,880	3,720
Pecatonica.....	5,427	.....
Iroquois.....	4,802	.....
Embarrass.....	2,942	1,230
Big Muddy.....	.....	1,935
Little Wabash.....	965	.....
Little Vermilion....	729	.....

According to this criterion the Kaskaskia ranks eighth among the rivers of the state.

At the time this census was taken commercial fishing in the Kaskaskia basin was limited to the main channel from Covington bridge to the mouth. This includes the course of the stream across Randolph, St. Clair, and about one-half of Washington, counties. Up to 1915 the entire river was open to commercial fishing. The history of its status since that time is outlined in the following records obtained from the office of the State Department of Conservation.

RECORD OF FISH PRESERVE ORDERS ISSUED IN CONNECTION
WITH THE KASKASKIA RIVER.

Jan. 14, 1915	Kaskaskia River and tributaries made a fish preserve.
Apr. 12, 1916	Kaskaskia River opened to commercial fishing from Carlyle to confluence with the Mississippi (but all tributaries remain closed).
May 31, 1921	Kaskaskia River and tributaries from Carlyle to Covington bridge made a fish preserve.
Sept. 15, 1927	Kaskaskia River and tributaries opened to commercial fishing in Fayette, Moultrie and Shelby counties.
June 5, 1928	Main channel of Kaskaskia River opened to net fishing, from the point where said river crosses the dividing line between Fayette and Clinton counties, south and southwest to the Covington bridge between Clinton and Washington counties,—all tributaries in said section of the river to remain preserves.
Oct. 1, 1930	Kaskaskia River and all tributaries made a fish preserve.

As shown in Table III, the bulk of the catch of fish in 1922 was carp and buffalo, together totalling 16,800 pounds and valued at \$1,835. Catfish and bullheads, weighing together 7,300 pounds, were valued at \$1,245. The drum, or sheepshead, contributed 5,200 pounds, worth \$640. Mussel shells and pearls, however, almost equalled fish in money value, comprising 43.6 per cent of the total commercial fishery in that year.

Perhaps a greater asset of the Kaskaskia consists of those intangible benefits accruing to health and enjoyment which result from use of the stream as a place of recreation. Throughout most of its length the river is large enough to afford ample opportunity for boating and swimming as well as angling. Numbers of fishing clubs have camps along the middle

reaches of the stream. These camps are especially numerous on the flood-bottom lakes in Clinton, Washington and St. Clair counties, but the river is visited at other points also by many people.

At the time this survey was being made on the Kaskaskia the NATURAL HISTORY SURVEY was also carrying on a similar survey of the Sangamon River. Since the same methods of study were used in both systems, we

TABLE III.—THE COMMERCIAL FISHERY OF THE KASKASKIA RIVER FOR 1922.*

PRODUCT	TACKLE						TOTAL		PER- CENT- AGE
	Fyke nets		Hand lines		Dredges, etc.				
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	
Buffalo.....	7,700	840	500	60	.....	.....	8,200	900	13.6
Carp.....	7,900	865	700	70	.....	.....	8,600	935	14.2
Catfish and bullheads..	6,800	1,120	500	125	.....	.....	7,300	1,245	18.9
Drum.....	5,100	620	100	20	.....	.....	5,200	640	9.7
Mussel shells.	.....	.....	.....	.....	104,000	1,560	104,000	2,880	43.6
Pearls.....	.....	.....	.....	.....	.....	1,285			
Slugs.....	.....	.....	.....	.....	.....	35			
Total.....	.....	.....	.....	.....	.....	.....	133,300	\$6,600	100.0

*Data from Sette (1925).

have a number of indices that reflect the relative importance of the two rivers from the point of view of fish production. These indices, showing that generally the Sangamon River is a somewhat more productive stream, are as follows.

COLLECTIONS WITH VARIOUS TACKLE	SANGA- MON	KAS- KASKIA
Average number of minnows per square yard	4.0	3.1
Average number of fishes per hoop net, per 24 hours.....	9.3	8.1
Average number of fishes per haul with tram- mel net.....	5.5	4.2
Average number of fishes per 100 hooks on trot-lines, per 24 hours.....	2.0	4.0

KINDS AND NUMBERS OF MUSSELS

FIVE general collections of mussels were made by hand at well distributed points on the Kaskaskia, with the various kinds appearing in the numbers shown in Table IV.

TABLE IV.—KINDS AND NUMBERS OF MUSSELS TAKEN IN THE KASKASKIA RIVER FROM JULY 30 TO SEPTEMBER 1, 1929.

	SULLIVAN	SHELBYVILLE	KEYESPORT	CARLYLE	VENEDY STATION	TOTALS
UNIONINAE						
<i>Quadrula lachrymosa</i> (Lea).....			4			4
<i>Quadrula pustulosa</i> (Lea).....	3	8	3	11		25
<i>Tritogonia tuberculata</i> (Barnes).....	6	1	3	12		22
<i>Megalonais gigantea</i> (Barnes).....				11		11
<i>Amblema rariplicata</i> (Lamarck).....			3	10		13
<i>Amblema costata</i> (Rafinesque).....	8	8	1			17
<i>Fusconaia flava</i> (Rafinesque).....		15	1	2		18
<i>Pleurobema catillus</i> (Conrad).....	8	8	1			17
<i>Elliptio dilatatus</i> (Rafinesque).....	6			1		7
ANODONTINAE						
<i>Strophitus rugosus</i> (Swainson).....	2	1	3	1		7
<i>Anodonta grandis</i> near var. <i>plana</i> (Lea).			1			1
<i>Arcidens confragosus</i> (Say).....				2		2
<i>Alasmidonta marginata</i> (Say).....	1					1
<i>Lasmigona costata</i> (Rafinesque).....	3					3
<i>Lasmigona complanata</i> (Barnes).....	2	3	1	4		10
LAMPSILINAE						
<i>Obliquaria reflexa</i> Rafinesque.....			1			1
<i>Truncilla truncata</i> Rafinesque.....			1			1
<i>Proptera alata</i> (Say).....	2	5	1	4		12
<i>Leptodea fragilis</i> (Rafinesque).....	2	1	19	3	29	54
<i>Actinonais carinata</i> (Barnes).....	26	16		1		43
<i>Ligumia recta</i> var. <i>latissima</i> (Rafinesque)				1		1
<i>Lampsilis ventricosa</i> (Barnes).....	3	11	17		1	32
<i>Lampsilis siliquoidea</i> (Barnes).....	4	12	7			23
<i>Lampsilis anodontoides</i> (Lea).....		1			3	4
<i>Lampsilis fallaciosa</i> (Smith).....	2	5	10	6	3	26
TOTAL.....						355

KINDS OF FISHES CAUGHT WITH VARIOUS TACKLE

TABLE V presents the hoop-net catches in the Kaskaskia River. The percentages in the last column of the table are summarized in Table VI and show that the hoop net catches consist predominantly of a few kinds of fishes. Thus the catfishes and bullheads make up 61 per cent of the entire catch, the sunfishes 28 per cent and all other kinds together the remaining 11 per cent. The high percentage of catfishes may be due to

TABLE V.—FISHES TAKEN BY HOOP NETS, KASKASKIA RIVER, 1929–1930.

SPECIES	NUMBER OF NET DAYS												TOTAL	PERCENTAGE
	7.96	9.71	11.58	7.08	8.00	13.54	6.12	10.37	2.00	7.00	16.83	1.87		
	SULLIVAN	SHELBYVILLE	COWDEN	VANDALIA	KEYSPORT	CARLYLE	VENEY STATION	NEW ATHENS	7 MILES ABOVE MOUTH	4 MILES ABOVE MOUTH	2 MILES ABOVE MOUTH	1½ MILES ABOVE MOUTH		
Silvery lamprey....										1	1		2	.2
Long-nosed gar....						1							1	.1
Short-nosed gar....					1			1			1		3	.4
Toothed herring...							1						1	.1
Eel.....				1			3	1			1		6	.7
Red-mouth buffalo.				1							1		2	.2
Mongrel buffalo....				1					1				2	.2
Small-mouth buffalo	1		2			1	1						5	.6
Quillback.....				5	1	9		5	5		3		28	3.4
Common red horse.	1												1	.1
Short-headed red horse.....	2	3	7			2							14	1.7
European carp.....			1	4	3	7	2	2					19	2.3
Blue cat.....								2					2	.2
Channel cat.....	3	20	8	5	14	25		3			6		84	10.2
Yellow bullhead....											1		1	.1
Speckled bullhead..										1			1	.1
Black bullhead.....				4					1	87	270		363	43.9
Mud cat.....	9	5	4	8	7	12	5	1			2	1	54	6.5
White crappie.....	1	7	35		2	18		5				3	71	8.6
Black crappie.....	3	1	2					2				1	9	1.1
Rock bass.....	11	8											19	2.3
Green sunfish.....	2												2	.2
Long-eared sunfish.	99	31	1										131	15.8
Bluegill.....												1	1	.1
Sheepshead.....				2	1			2					5	.6
Total Number of Fishes.....	132	75	60	31	29	75	12	24	7	89	286	6	827	
AVERAGE NUMBER OF FISHES PER NET PER DAY...	16.58	7.72	5.18	4.38	3.62	5.54	1.96	2.31	3.5	12.71	16.99	3.21	8.10	

their seeking the hoop nets as places of concealment. Sunfish likewise seek concealment in brush and around stones and may also enter the hoop nets for the same reason. Suckers, carp and buffalo, being active and strong swimmers and seeking open waters as a rule, are rarely caught in small-mesh hoop nets. Table VI shows percentages of the different kinds of larger fishes caught by various kinds of tackle. The second column of this table shows the fishes caught by means of a trammel net. Though the total number caught by this method was very small, the proportion of the various kinds of fishes, even in such small numbers, indicates a marked contrast to the catch by hoop nets. More than half the trammel-net catch consists of suckers, carp and buffalo—the kinds that ordinarily avoid hoop nets. Sunfishes make up a much smaller percentage, and catfishes, which represented the largest percentage of the hoop-net catch, were not taken at all in the trammel net. Trot-line catches were so small as to lack significance except for the 13 carp, which were taken on soaked corn.

TABLE VI.—COMPARISON OF NUMBERS AND KINDS OF LARGER FISHES TAKEN WITH DIFFERENT KINDS OF TACKLE.

KIND OF FISH	NUMBER TAKEN		
	Hoop net, 1-inch mesh, with wings. 102.1 days	Trammel net, 1-inch mesh, 6x75 feet. 12 hauls	Trot-line—50 hooks baited with soaked corn, minnows and fish. Set for 8.8 days
<i>SUNFISHES</i>			
Rock bass	19		
White crappie	71		
Black crappie	9		
Bluegill	1		
Long-eared sunfish	131	7	
Green sunfish	2		
Total	233 (28%)	7 (10%)	
<i>CATFISHES</i>			
Channel cat	84		4
Blue cat	2		
Mud cat	54		
Black bullhead	363		
Speckled bullhead	1		
Yellow bullhead	1		
Total	505 (61%)	Continued	Next Page

FACTORS AFFECTING THE ABUNDANCE OF FISHES IN THE KASKASKIA

SINCE one of the aims of this reconnaissance of the Kaskaskia River was to obtain information on its fitness for the production of fishes, some general observations were made on the conditions in the stream as a basis for comparisons with other streams in Illinois.

Bottom.—The small bottom animals constitute the most important source of food fishes in this stream as well as in most of the other, larger Illinois streams. Rather extensive collections of bottom fauna are being worked over and a full account of their kinds and amounts will be included in a later report. Superficial inspection of the organisms found in the samples indicates that they occur in amounts common to Illinois streams of this size. The prevailing kind of bottom in the Kaskaskia is sand and

TABLE VI.—CONTD. COMPARISON OF NUMBERS AND KINDS OF LARGER FISHES
TAKEN WITH DIFFERENT KINDS OF TACKLE.

<i>CARP and SUCKERS</i>			
European carp.....	19	16	13
Red-mouth buffalo.....	2		
Mongrel buffalo.....	2		
Small-mouth buffalo.....	5	3	
Silver carp.....	28	2	
Chub sucker.....	1	2	
Common sucker.....		17	
Hog sucker.....		3	
Common red horse.....	1	8	
Short-headed red horse.....	14	2	
Total.....	72 (9%)	53 (77%)	
<i>MISCELLANEOUS FISHES</i>			
Common shiner.....		4	
Flat-headed chub.....	1		
Silver lamprey.....	2		
Long-nosed gar.....	1	2	
Short-nosed gar.....	3		
Dog fish.....			1
Toothed herring.....	1	1	
Gizzard shad.....		2	
Sheepshead.....	5		
Eel.....	6		
Total.....	19 (2%)	9 (13%)	
GRAND TOTAL.....	829 (100%)	69 (100%)	18

gravel. Exhaustive studies of the amounts of small bottom animals available as fish food on rock, gravel, sand, and mud bottoms have shown that sand is least productive, while gravel may be of intermediate or of superior productivity.

Plankton.—The few plankton collections taken in July and August, 1929, seem to show that plankton is of very slight importance as a source of fish food in the main stream. Practically no plankton organisms were found in the collections except in the one taken just above the mouth



Fig. 8.—Kaskaskia River at Evansville, July, 1930.

of the river, and even this collection contained only 11 species, none of which was very abundant.

Vegetation.—Streams which have considerable amounts of submerged aquatic vegetation are quite commonly found to be our heaviest producers of fish. Such vegetation, besides serving directly as food for fish, provides favorable situations for the production of large amounts of small animal life which serve as fish food. Such vegetation also provides cover and protection for many kinds of young fishes. Other studies of the ILLINOIS NATURAL HISTORY SURVEY have shown that the high fish productivity of the Illinois River is intimately associated with the wide areas of connecting bottomland lakes and sloughs. Along the course of the Kaskaskia through Bond, Clinton, Washington and St. Clair counties there are numerous floodplain lakes and sloughs, but the total area of these is so small that it is not likely that they materially affect the yield of fishes. The submerged

aquatic vegetation of the Kaskaskia system is limited to the smaller head-water streams. The factors which seem to determine the presence or absence of submerged aquatic vegetation in Illinois streams are (1) turbidity, (2) nutritive substances brought in from the soils of the drainage basin and (3) constancy of flow. The turbidity of the Kaskaskia throughout most of its length is so great that light probably cannot penetrate the water sufficiently to allow the growth of submerged vegetation. Scarcity of nutritive substances for plants from the less fertile soils of the area covered by the Illinoian glaciation may have something to do with the lack of vegetation. The water level in the Kaskaskia is subject to such variations that plants are either drowned or left stranded.

Enemies.—All game fishes feed for the most part upon minnows and other small fishes. Our minnow-seine collections show that there is a plentiful supply of this kind of food throughout the Kaskaskia River and that in number of minnows per square yard of water it compares favorably with other rivers of the state.

Natural enemies of fishes in the Kaskaskia appear to be of the same kinds and numbers as in other streams of the state, except for sporadic depredations of the lamprey, which will be described later. Thirty-two turtles were taken in the hoop nets during this survey, a number of which were large snapping turtles which commonly devour several fishes each day. Herons, kingfishers and other water birds which feed almost exclusively on fishes were noticed at many places. Minks, otters, muskrats and raccoons also take their toll of fish life.

Fishing.—From 1916 to 1930 commercial fishing was permitted in the lower reaches of the Kaskaskia. As shown by the reports of the United States Bureau of Fisheries (Sette, 1925), the important commercial kinds taken were carp, buffalo, catfish and sheepshead. Since buffalo and certain other suckers are rarely caught with hook and line their removal with nets and seines does not materially affect hook and line fishing. Commercial fishing may, however, reduce the numbers of carp, catfish and sheepshead available to hook and line fishermen. While bass, crappie and sunfish are supposed to be returned to the water when taken with commercial tackle, the temptation to keep these game fishes is very often too great. Continued operation of trot-lines may have some effect in lowering the numbers of certain kinds of fishes in the stream. During our survey we encountered several men who were making their living by catching sheepshead and catfish with trot-lines. One of these fishermen reported catches of 120 channel cat in a single night as not uncommon with the amount of tackle that he alone used.

Disease.—Practically all of the fishes taken in the course of this study appeared to be clean and healthy. This does not indicate, however, that

disease is not an important factor affecting the abundance of fishes in the Kaskaskia, just as in other streams, since there is a wide variety of diseases which probably take a small but steady toll of fishes, with only an occasional outbreak which may kill off large enough numbers to be noticed. Dead fishes are quickly devoured by scavengers both in water and on land, and diseased or injured fishes with slow or erratic movements are easily caught by predators.



Fig. 9.—Kaskaskia River 2 miles above the mouth, July, 1930.

Pollution.—Finally, abundance of fishes is influenced by the amount and kind of pollution which a stream has to bear. The sewage load of the Kaskaskia, or Okaw, is small and has little effect except during periods of low water, when some stretches, especially in summer, may become heavily polluted. For example, a septic condition existed below Carlyle in July and August of 1930. The untreated domestic sewage which goes into the river at Carlyle is augmented by wastes from a strawboard factory and a milk plant. As a result of this pollution, for a distance of at least 25 miles downstream there was no dissolved oxygen in the water. Thousands of fishes were killed, and all the bottom animals, such as mussels and snails, must have perished also. The water was black, a layer of black sludge several inches thick covered the bottom and a strongly putrescent odor was apparent, even at some distance from the stream. Normally this section of the river is a very productive one.

About 100,000 people live in the Kaskaskia basin in towns and cities

of more than 500 population. The river receives untreated sewage from about 17,000 of these people and effluent from treatment plants in cities representing a population of 65,000. A remainder of some 20,000 persons resides in cities and towns with no sewer systems (Buswell, 1927).

Since the Kaskaskia basin consists predominantly of agricultural lands, without large industrial centers, the chief industrial wastes received by the river are such as result from treatment of agricultural products, particularly wastes from milk products plants and strawboard factories. In the southern part of the river basin there is considerable coal mining and a few limited areas which produce oil, but pumpage from these mines and wells is believed to have negligible effect on the river.

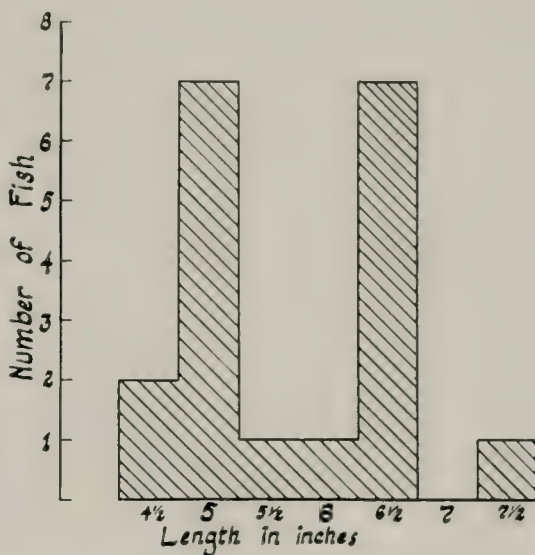


Fig. 10.—Age groups of rock bass.

THE RATE OF GROWTH IN FISHES

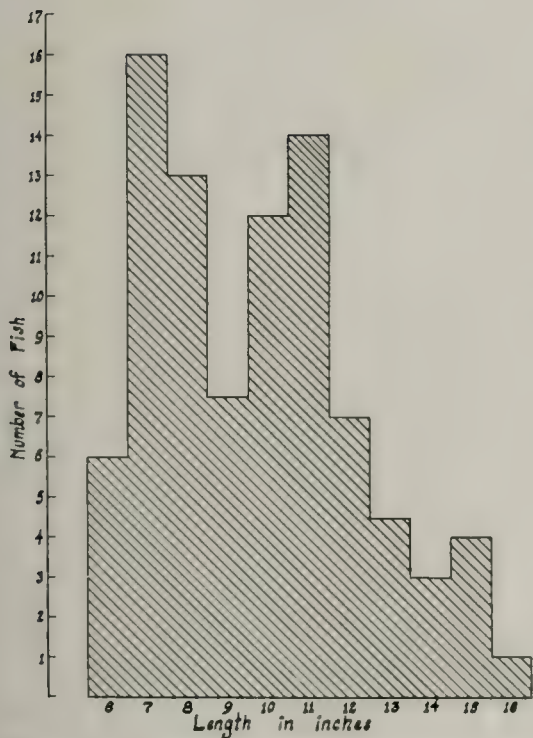


Fig. 11.—Age groups of channel cat.

SINCE most fishes spawn in a certain restricted season of the year and since the young grow at approximately the same rate, the different age groups can often be recognized. If the lengths of a considerable number of individuals of the same species taken from one area in a short period of time are plotted in the form of a frequency curve, these groups appear as humps in the curve. During the course of our study, data on the lengths of several species of fishes were obtained. These measurements were made from the tip of the snout to the base of the caudal fin. The data for rock bass, channel cat and mud cat show these age groups most distinctly and are presented in Figs. 10, 11 and 12.

Figure 10 presents graphically the lengths of 19 rock bass. These measurements fall into two well separated groups, each representing a year class. One group, probably two years old, varies from $4\frac{1}{2}$ to $5\frac{1}{2}$ inches with a mode at 5 inches, while the other group varies from 6 to $7\frac{1}{2}$ inches with a mode at $6\frac{1}{2}$ inches and is made up presumably of three-year old fish.

In Fig. 11, which summarizes the data for 88 channel cat, three fairly well defined groups appear, presumably representing fishes two, three and

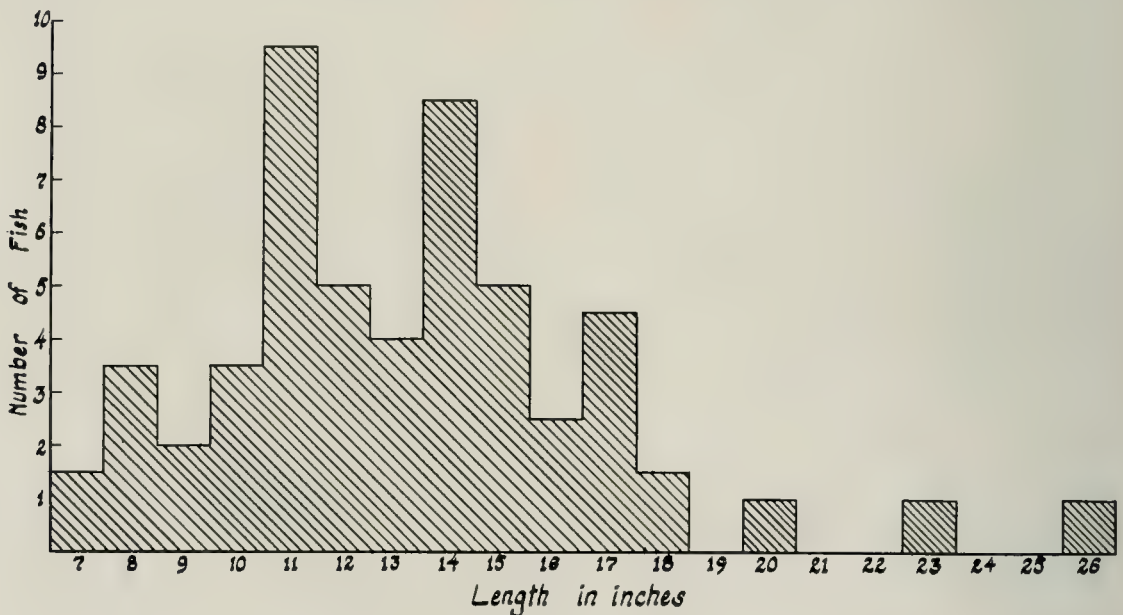


Fig. 12.—Age groups of mud cat.

four years old. Fishes of the first group vary from 6 to 9 inches with a mode at 7 inches; the second group, from 9 to 13 inches with a mode at 11 inches. Those of the third group appear to vary around 15 inches as a mode.

The data for mud cat are arranged graphically in Fig. 12, which shows modes at 8, 11, 14 and 17 inches. The three individuals 20, 23 and 26 inches in length may represent three additional year groups.

A better method of age determination is by examination of scales, spines and bones, which show annulations indicating the age and past history of individuals in much the same way as do the annual rings in the trunk of a tree. During the course of this study spines or scales were taken from most of the fishes caught, and an analysis of these data will form the subject matter of later reports.

THE FISHES OF THE KASKASKIA

IN this section are presented some of the more obvious distinguishing characteristics of each of the larger fishes, a summary of known informa-

tion concerning the life history of the more important ones, their food, their interrelation with other fishes, their usefulness, sizes, weights, distribution, etc. Those fishes which are rare or are so small as to be insignificant in the fishery have been treated very briefly, while the more important hook and line and commercial fishes have been treated more fully.

LARGE FISHES

Silvery Lamprey

Ichthyomyzon concolor (Kirtland)

The lamper eel is an elongate scaleless fish-like animal without paired fins, which reaches a length of 16 inches. It is also called lamper, river lamprey or silvery lamprey. By means of its mouth, which is expanded into a round sucking disc furnished with teeth for rasping, it attaches itself to larger fishes and rasps through the scales and into the flesh to feed on the blood.

Our records indicate that lampreys have their most serious effect during winter. In the study made on the lower Kaskaskia in the late summer of 1929 no lampreys were taken, and none of the large fishes upon which they commonly prey showed lamprey marks. In the field work on the lower Kaskaskia and in the Mississippi River near the mouth of the Kaskaskia in the late winter and early spring of 1930, numbers of lampreys were taken attached to carp, buffalo, spoonbill, catfishes and suckers. Mr. Barber, a commercial fisherman of Chester, said that in some winters the lampreys have destroyed nearly all of the carp in the lower Kaskaskia. Such an outbreak occurred during the winter of 1927-1928, and many tons of carp were destroyed and washed up dead along the banks. Less serious depredations occur nearly every winter. It is supposed that carp, being more sluggish than other fish in winter, fall an easy prey to lampreys.

While the important facts of the life history of the lake lamprey, *Petromyzon marinus dorsatus* Wilder, and of the brook lamprey, *Lethenteron appendix* (DeKay), have been well established, very little is known concerning the silvery lamprey. While our numbers and measurements of this lamprey were inadequate, members of the field party record the distinct impression of two or three size groups only in the lampreys caught, which would indicate that this species lives only a few years. The larger specimens appear to be especially voracious, and this increased consumption of food may be in preparation for sexual maturity and the production of eggs and milt. In all other lampreys, and probably in this one also, the production of the new generation causes such a drain upon the resources

of the adults that they die soon afterward. We have noticed that the largest individuals are taken in late winter and spring and only medium sized ones in summer. This seems to indicate that the large adults die in spring.

Spoonbill Cat; Paddlefish

Polyodon spathula (Walbaum)

The spoonbill cat may be readily recognized by its large paddle-shaped snout. It is the most primitive of the bony fishes, and its nearest living relative is found in the large rivers of China. The paddle is considered to be a greatly enlarged sense organ, by means of which the fish detects the presence of those small organisms in the water which are its principal source of food. The paddle is waved back and forth as the fish swims along, with its mouth agape, straining the organisms from the water by means of its greatly elongated and numerous gill rakers. The spoonbill is usually held as an example of a fish that feeds exclusively upon plankton, but large numbers taken in the spring of 1930 in the Mississippi River at Chester contained nymphs of the mayfly, *Hexagenia*, and a few small fishes.

This is a highly prized market fish, selling (under the name of "boneless cat" or "spoonbill cat") when fresh at about the same price as channel cat or blue cat, and when smoked at about the same price as smoked sturgeon. Its roe is used for making caviar. Considerable numbers are regularly taken by commercial fishermen in the lower Kaskaskia and in the Mississippi near Chester.

Very little is known concerning the spawning habits and life history of this fish, in spite of the fact that many investigators have worked on the problem. Because of this we were especially interested to hear the fishermen report the presence of very small paddlefish in the Kaskaskia. Mr. H. C. Moore, a commercial fisherman of Chester, stated that he had seen spoonbill fry not more than 3 inches long in late summer in the lower reaches of the river. Both he and his partner were of the opinion that spoonbills spawn near the mouth of the Kaskaskia. Mr. Barber, another fisherman at Chester, said that he had seen young spoonbills about 4 inches long, also in late summer. The smallest specimen taken by us measured $7\frac{1}{2}$ inches, including paddle and tail, and we have numerous specimens varying from this length to 12 inches over all, taken in the late winter and early spring of 1930. Since the spoonbills caught in the Kaskaskia rarely weigh more than 4 pounds and do not contain roe, it is difficult to see how any spawning occurs there unless the gravid adults visit the river only long enough to spawn, departing before the seining season opens.

Gars

Lepisosteus osseus (Linnaeus)

Cylindrosteus platostomus (Rafinesque)

Lepisosteus platostomus Rafinesque³

The gar-pikes may be recognized by their elongate cylindrical bodies, their beak-like jaws and the bony rhombic plates or scales that cover their bodies. In the long-nosed gar, *Lepisosteus osseus*, the beak is much longer and more slender than in the short-nosed gar, *Cylindrosteus platostomus*. Thus in the former the length of the beak is about 20 times the width near the tip, but in the latter only five or six times the width.

These alert and voracious fishes are very destructive, feeding on nearly all kinds of fishes, and competing with game fishes for food, so that they are capable of decreasing seriously the productiveness of streams where they are numerous. They are of no use whatever to man. For these reasons it is customary to destroy all gars caught. While common in the Kaskaskia, especially from Shelbyville to the mouth, they are not plentiful enough to have any very serious effect upon the fish life of the stream.

In the summer months, particularly in the more sluggish parts of the river, the gars may be seen "breaking" at the surface of the water, to renew the supply of air in their lung-like swim bladders—sticking out their beaks and opening and closing their jaws with a snapping sound. The swim bladder of these fishes is unique in that it is equipped with an abundance of small blood vessels and functions efficiently as a lung. Indeed, gars have been taken often in polluted waters with no dissolved oxygen, where they drown within a few minutes if held beneath the surface. The gills are small and seemingly inadequate, because the gars die sooner than other fishes if held in oxygen-deficient water.

Alligator Gar

Atractosteus tristoechus (Schneider)

Lepisosteus tristoechus (Block & Schneider)

No specimen of the alligator gar was taken by us in the Kaskaskia, though fishermen state that this fish is common at certain times near the mouth of the river. It has a shorter beak than either of the aforementioned gars, and it grows to a much greater size, individuals measuring 10 feet in length and weighing 300 pounds having been seen in this vicinity. It also differs from the other gars in that the large teeth of its upper jaw are in two rows on each side instead of being in a single row.

³Nomenclature follows Jordan, "Manual of the Vertebrate Animals of the Northeastern United States." 1929, 13th edition. Names in small type are those of Forbes and Richardson in "The Fishes of Illinois," 1909.

The following information regarding the alligator gar comes from Mr. Leslie Crow, of Chester, who fishes in the lower Kaskaskia.

About the first week in June, 1930, 75 to 100 gars entered an overflow pond on the river bottom about 2 miles above the mouth of the river. The pond was connected to the river by a cut in the bank, through which the fishes entered. The water was 2 to 4 feet deep in this pond, which consisted of a number of acres of wooded bottomland with considerable underbrush. May of these gars were judged to weigh 100 pounds, but a few of them were 10 feet long and may have weighed 300 pounds. The gars were spawning in this place, so that the shrubs, bushes, and other objects in the water were covered with eggs.

A special harpoon was made of a $\frac{3}{8}$ -inch rake tooth. This was pointed and heavily barbed at one end. A loop in the middle of the shaft formed an attachment for a heavy line. The upper end was straight and blunt and fitted into a hole in the end of a long pole which served as a handle. When a hit was made, the pole was withdrawn, leaving the harpoon point. The line attached to the harpoon was 30 to 40 feet long and at its other end was attached a 10-gallon can that was tightly sealed. Carrying this buoy and line, the fish finally exhausted itself and was taken.

Another method of catching alligator gar in this part of the river is by means of a large hook and a long line of quarter-inch rope. A special hook is made of quarter-inch spring steel and is baited with fish heads and the like. When a fish is hooked it is played from the bank until it is worn out, and then killed.

A number of people have stated that the eggs of these gars are poisonous. One man reported that roe from one alligator gar killed 90 chickens.

During the first week in August, 1930, several of these gars were seen about the piling at the mouth of the Kaskaskia. Another one was seen "rolling" on the surface of the water near Chester.

Such huge and voracious animals must levy a heavy tax upon the fish life of an area, and the number of fish destroyed by a single alligator gar during its lifetime must be very large.

Dogfish; Bowfin

Amia calva Linnaeus

This fish is known by many names, the more common of which are dogfish, bowfin, grindle and grinnel, the last being the name commonly used by fishermen of the Kaskaskia. It is of little importance in this river, for it is comparatively rare and is not used to any extent as food. In our survey only one specimen was seen, and that was taken at Vandalia. Fishermen, however, vouched for the occurrence of the dogfish in other

parts of the stream. It preys upon other fishes, crustaceans and mollusks.

Toothed Herring; Moon Eye

Hiodon tergisus Le Sueur

The toothed herring or moon eye was taken by us at three places, one specimen 2 miles south of Parkville near the headwaters of the Kaskaskia, one at Venedy Station about 50 miles from the mouth of the stream, and six young individuals 3 inches long about 11½ miles above the mouth. Though widely distributed in the stream, it is nowhere abundant and is of little importance to the fishery.

Gizzard Shad

Dorosoma cepedianum (Le Sueur)

The gizzard shad is abundant in the lower course of the Kaskaskia at certain seasons but is comparatively rare in the upper reaches. Two adults and eight fingerlings were taken in minnow-seine collections between Shelbyville and Venedy Station. This fish feeds on organic detritus on the bottom and on minute plant and animal life suspended in the water. Its preference for muddy bottom probably explains its rarity except near the mouth. Though not used by man for food, the gizzard shad in many streams and lakes of Illinois serves as the most important supply of animal food for game fishes. Gizzard shad fingerlings are often taken in quantities in the lower Kaskaskia and salted down for trot-line bait.

This species may be separated from the moon eye, which it superficially resembles, by the comparatively greater depth of the body, the great extension of the last rays of the dorsal fin and absence of a lateral line and of teeth.

Eel

Anguilla bostoniensis Le Sueur

Anguilla chrysypa Rafinesque

The eel is represented in our survey of the Kaskaskia by five specimens, four of which were tagged and released. One of these was recaptured a few hours later in a net about 50 yards upstream. One of the specimens taken at New Athens was 36 inches long and weighed 4 pounds. Reports from fishermen along the river indicate that eels are not uncommon from Shelbyville on down, although they are nowhere plentiful.

The eel feeds almost exclusively on fishes and is very voracious. The flesh contains somewhat more fat than most of our native fishes and is regarded as a delicacy by many people. On the market it brings about the

same price as catfish. Considerable interest in its life history has been aroused in recent years following the discovery of its spawning grounds in the Sargasso Sea.

Buffalo

Megastomatobus cyprinella (Cuvier & Valenciennes)

Ictiobus cyprinella (Cuvier & Valenciennes)

Ictiobus urus (Agassiz)

Ictiobus bubalus (Rafinesque)

There are three species of buffalo fish, all of which are found in the Kaskaskia. Twelve specimens were collected from nine localities between Sullivan and the mouth of the river. Since eight of the 12 were the small-mouth, *Ictiobus bubalus*, this species seems to be more common than the other two in the Kaskaskia and to extend farther upstream. The commercial catch of buffalo in 1922 was 8,200 pounds valued at \$900 (Table III). Thus buffalo holds second place in weight and third place in value in the fishery of the Kaskaskia, being exceeded slightly in weight by carp and in value by catfish and carp. Mr. Hanke, manager of the fish hatchery at Carlyle, said that fishermen were catching buffalo in considerable numbers near Carlyle in August, 1930. The greater part of the catch was made with fyke nets and the rest with seines and set-lines.

The buffalo commonly attains a length of 3 feet and a weight of 50 pounds (Forbes and Richardson, 1909). The flesh is readily marketable at a price somewhat higher than that for carp. In Illinois it is usually preferred to carp in flavor and texture. Spawning occurs early in the spring, usually in April, and enormous numbers of eggs are shed around the margins of backwaters and sloughs. About a third of the food consists of vegetable material, and the rest is made up mainly of insects, entomostracans and mollusks.

According to Sette (1925), the buffalo is one of the few fishes that

YEAR	POUNDS
1894.....	15,924,810
1899.....	14,215,975
1903.....	11,491,663
1908.....	15,040,000
1922.....	15,488,765

has maintained itself in undiminished numbers in the Mississippi River and its tributaries. The foregoing table shows the annual yield of buffalo fish in the Mississippi system for selected years from 1894 to 1922.

Carp Suckers

Carpiodes carpio (Rafinesque)

Carpiodes difformis Cope

Carpiodes cyprinus (Le Sueur)

Carpiodes velifer (Rafinesque)

Three species of carp suckers were found in the Kaskaskia. They are also called native carp, river carp, silver carp, silvereens, quillback and spearback. Twenty-one specimens of *Carpiodes carpio* were taken and ten of these were tagged and released. Seven specimens of *C. difformis* were taken and two of them were tagged and released. Seven specimens of *C. cyprinus* were taken and three of them tagged and released.

The carp suckers are bottom feeders and are of little importance to the life of the stream. They form a small part of the commercial catch near the mouth of the river, but on account of their poor quality they are much the least profitable part of the catch, although they compare favorably with other fishes when smoked.

Common Sucker; Black Sucker

Catostomus commersonii (Lacépède)

The common sucker, which is also called the fine-scaled or black sucker, may be distinguished from the other suckers by the large number and small size of the scales on the front half of its body. This sucker is found in tributaries and headwaters of the Kaskaskia but rarely in the main stream. Thus all but one of our 29 specimens were taken in the headwaters of the Kaskaskia in Champaign county.

The black sucker can be taken on worms in spring and makes up a large part of the catch by small boys. It ascends creeks and spawns on riffles in March and April. When caught in cold water, the flesh of this fish is white and firm and of good flavor. It is quite bony, however, and when taken from warm water the flesh is soft and unpalatable.

Hog Sucker

Hypentelium nigricans (Le Sueur)

Catostomus nigricans Le Sueur

The hog sucker may be recognized by its peculiar protusile sucking

mouth and by its large broad square head. In the Kaskaskia it is confined to the upper third of the basin, which is the clearer and swifter part of the stream, where seven specimens were taken. This fish lives in the swifter parts of creeks, where it feeds from the bottom by rolling over stones and sucking up the material thus exposed. It maintains its position in swift water by resting upon its fins, but when alarmed it darts away in a zigzag course. In consequence of its feeding habits and its choice of habitat, it has assumed those structural adaptations characteristic of the darter family. It is occasionally taken on the hook but is not valued as food and is not important.

Chub Sucker

Erimyzon sucetta oblongus (Mitchill)

The chub sucker or sweet sucker is represented in our minnow-seine collections in the Kaskaskia by 93 specimens, all taken at Shelbyville or above. Its preferred habitat is in small streams. Since it never becomes very large it is not important commercially, but it is often used as bait in lieu of large minnows.

Spotted Sucker

Minytrema melanops Rafinesque

One spotted sucker was taken near Parkville. Though now rare in the Kaskaskia it was abundant there when Forbes and Richardson made their collections for "The Fishes of Illinois."

Common Red Horse

Moxostoma aureolum (Le Sueur)⁴

The 28 specimens taken in the course of this work show that this red horse is a common fish in the Kaskaskia. Nine adults were taken in the upper reaches of the river at Parkville and Sullivan, and 19 young were taken between Shelbyville and Venedy Station. The red horse shows a strong preference for the smaller clear rivers with sandy or rocky bottom.

Among the suckers this is one of the best for food, and it reaches a weight of 5 or 6 pounds. It appears on the market under the name of white mullet. It feeds mostly upon mollusks and aquatic insects and is readily taken in spring on hooks baited with worms. Its breeding season is in May and June, the adults ascending the smaller streams and spawning on the riffles.

⁴This and the following species of red horse, common throughout Illinois, do not approximate closely any of the descriptions listed in Jordan (1929).

Short-headed Red Horse

Moxostoma breviceps (Cope)

The short-headed red horse is distinguished from the common red horse by its tail fin, which is blood red instead of yellowish or pale orange, and by its distinctly smaller head. Sixteen adults were taken from five localities in the upper and middle reaches of the river, and 14 of these were tagged and released, but we have had no returns up to the time of writing. Its habits and table qualities are similar to those of the common red horse.

Carp

Cyprinus carpio Linnaeus

The carp may be distinguished from all other Illinois fishes by the four barbels found about its mouth and by the teeth on the spines of its anal and dorsal fins. This species is a native of Asia and was introduced eight or ten centuries ago into Europe, where it has been extensively cultivated. Its first introduction into this country in sufficient numbers to become established was in 1877. The first imports were distributed by the United States Bureau of Fisheries to private individuals who reared them in ponds. The fishes escaping from these ponds into public waters increased rapidly in number and became widespread.

Today the carp is one of the most important species in the inland fisheries of the United States. It forms a larger part of the fish yield of the Kaskaskia than any other species. Sette (1925) gives the catch of carp in 1922 in the Kaskaskia as 8,600 pounds valued at \$935.

The mirror carp, which has a few greatly enlarged and irregularly shaped scales as well as smaller scales around the bases of the fins, was formerly very common in Illinois waters. In our work on the Kaskaskia only one specimen of this variety was taken.

That the carp is common in the Kaskaskia from its mouth up as far as Sullivan is indicated by our collections and by information from fishermen. We took 49 specimens in all, 34 of which were tagged and released in an effort to gain more definite information about the growth and movements of these fishes. The average weight and length of our specimens was 21½ pounds and 15½ inches, respectively.

There are many moot questions concerning the food of the carp. Cole (1904) concluded that a large proportion of the material in the alimentary tract was of vegetable origin, and Tracy (1910) found the chief part of the diet of carp to be made up normally of vegetable matter. Pearse (1918) states that young carp feed at first on entomostracans and rotifers, and then

chiefly on insect larvae, but that adult carp are omnivorous, with vegetation forming a large part of their food. Forbes and Richardson (1909) state that the adult carp are "omnivorous feeders, taking principally vegetable matter, but insect larvae, crustaceans and mollusks, and other small aquatic animals as well." Smallwood and Struthers (1927) state that their studies of the food of adult carp of Oneida Lake clearly indicate a preference for animal food. Struthers (1928) examined the digestive tract of 42 adult carp from the barge canal and the Oswego canal, and his results show that the food of these carp consisted of 31.4 per cent plant material and 68.6 per cent animal matter. Struthers admits that carp show a selective preference for certain plant food, such as corn and potatoes, which are much used for bait.

Since the carp is admittedly an omnivorous feeder, it seems probable that its diet varies under different conditions. Where no water plants or other vegetable materials are present the carp feeds almost exclusively upon animal material; where much plant material and little animal material are present the carp feeds upon the former; and where both are present it eats both. It is certain that in the main stream of the Kaskaskia carp depend almost wholly upon animal food, as there is very little vegetation available. It may be added that an examination of the stomach contents of more than 100 carp from Illinois waters has failed to show any fish eggs or fish of any kind.

Carp usually lay their eggs in May and June, and less frequently throughout the summer. These hatch in 4 to 12 days, depending primarily upon the temperature of the water. The young carp grow very rapidly, often reaching a length of 6 inches or more and the weight of $\frac{1}{2}$ pound during the first summer. In a slough at Vandalia on August 15, 1929, 16 young carp varying from 4.3 to 5.1 inches in length (measured from the end of the snout to the base of the caudal fin) and weighing 2 to 3 ounces were taken by seining. These undoubtedly were of that season's hatch and indicate something of the rapidity of growth of young carp. At the end of the first year carp usually weigh a pound and at the end of the second, 2 pounds.

In many places carp have been condemned because of the detrimental effect they have upon game fishes, such as bass and crappie. Carp have been accused of eating the spawn and young of more desirable fishes, but there seems to be very little evidence to support this accusation. Since it appears that carp feed to a considerable extent upon animal matter, they are competitors of game fishes for food. On the other hand young carp probably serve as an important item of food for the larger game fishes, particularly black bass and wall-eyed pike. There seems to be some evidence, in other

streams at least, that increase in the number of carp is accompanied by an increase in the number of bass.

Another common objection to the carp is that, by their method of feeding on the bottom and tearing up vegetation, they keep the water so roiled that the sun is unable to penetrate the water and aquatic plants are unable to grow. However, in a stream like the Kaskaskia, which is always carrying a great amount of suspended matter, natural turbidity prevents plant growth and the work of carp has negligible effect upon clearness of the stream.

Though very little is known about the subject, carp are usually considered to be nomadic but not migratory fishes. They spend the colder months in the deeper pools and ordinarily do not feed from October to March. So far we have but two returns from the 34 tagged individuals released in the Kaskaskia. One of these had traveled upstream $1\frac{1}{2}$ mile when it was retaken 8 months and 22 days later, the other had traveled downstream 20 miles and was taken 10 months and 6 days after its release.

Blue Cat

Ictalurus furcatus (Cuvier & Valenciennes)

The blue cat or Fulton cat is the largest of the native catfishes, for it may grow to exceed 150 pounds. It is the characteristic catfish of the Mississippi River, and fishermen report that it is common in the Kaskaskia as far upstream as Cowden, about 200 miles above the mouth. Our collections, however, include only two small specimens 8 inches long, both taken in unbaited hoop nets at New Athens.

At Chester on the Mississippi, blue cats are caught by seining, by set lines and by "blocking," which is a perfected form of "jugging." From 15 to 25 molasses pails, gallon jugs or wooden blocks are used as floats and tied at intervals of about 10 feet along a stout line. To each of these floats is tied a snell about 6 feet in length, with an 8/0 hook. The large fresh-water shrimp, *Palaemon ohionis* Smith, is the preferred bait, although gizzard shad and other small fishes are often used. One end of the cord carrying the floats is fastened to a boat, and the fisherman with an occasional pull on the oars guides the line of blocks as it floats downstream. With this type of apparatus many large blue cats and mud cats are caught, especially in the summer months.

Coker (1929), from observations by Stringham, reported that the blue catfish breeds near Keokuk, Iowa, in June. In February and March, 1930, large numbers of blue cats 1 to 3 inches in length were taken in and

about the mouth of the Kaskaskia.

The blue cat is predominantly a fish-eating species, although the successful use of large fresh-water shrimp for bait indicates that this crustacean, which is present in the Mississippi in large numbers from spring until autumn, may form a considerable part of the blue cat's food.

The blue cat is prized very highly as a food fish. Most anglers place it slightly below the channel cat in flavor and firmness of flesh, but it brings an equally high price. It may be separated from the channel cat by its greater depth in the shoulder region, its light blue color instead of slate tinged with bronze, and by the absence of dark spots which are usually present in the channel cat.

Channel Cat

Ictalurus punctatus (Rafinesque)

The channel cat or fiddler is the most abundant and probably the most important catfish of the Kaskaskia. Our collections included 131 specimens, of which 43 were young fry from 1 to 3 inches long, taken with the minnow seine during August, 1929. That the fry were found from Shelbyville to the mouth of the river indicates that this entire stretch of stream may serve as a breeding ground. Coker (1929) reports observations which indicate that it spawns in June and July at Keokuk. Pond culture experiments at Fairport were successful in that some fry were produced, but the number of young was very small compared to the number of breeding adults. Of the 88 adults taken in our collections 81 were tagged and liberated, but we have not yet had any returns. These averaged 12 inches long and 1½ pound in weight.

In some parts of the stream the channel cat is especially plentiful, one fisherman near Shelbyville reporting catches up to 120 from set lines in one night. Since this fish is a lover of swift water, the fishermen set their lines preferably at the head of rapids. Crayfish, dead minnows, clam meats and cheese are the usual baits. Forbes and Richardson's data, based on examination of 43 specimens from the Illinois and Mississippi rivers, indicate that it is an omnivorous feeder, vegetable matter making up about one-fourth of its food, and insects, mollusks and small fishes comprising the remainder.

While it is reported to reach a weight of 25 pounds, the largest channel cat taken in our smaller rivers like the Kaskaskia do not exceed 5 pounds. The flesh is white and firm and has a delightful flavor. It is the most highly prized of the catfishes as food, and by many anglers it is given first place among all fresh-water fishes.

Bullheads

Ameiurus natalis (Le Sueur)

Ameiurus nebulosus (Le Sueur)

Ameiurus melas (Rafinesque)

The black bullhead, *Ameiurus melas*, is by far the most abundant of the bullheads occurring in the Kaskaskia basin. The yellow bullhead, *A. natalis*, and the speckled bullhead, *A. nebulosus*, occur rarely. Thus 366 specimens of *A. melas* were taken in our survey but only three specimens of *A. natalis* and one of *A. nebulosus*. None of the bullheads is abundant in the main stream during the summer months. Only four specimens were taken during our work in August from Sullivan to the mouth of the river, and these were taken at Vandalia just after a rise of several feet following a shower.

Bullheads prefer sluggish and quiet waters, and this probably accounts for their absence from the main stream of the river during the summer. At this season they are in pools of creeks and in the lakes and overflow ponds of the river bottom. A few overflow ponds were seined and in each we found bullheads, usually adults and young.

In contrast to their scarcity in summer, bullheads were the fishes taken most abundantly in hoop nets near the mouth of the Kaskaskia in the early spring of 1930. This indication of a migratory habit among them is borne out by our returns from bullheads that were tagged. We have ten returns from the 281 black bullheads tagged in the spring of 1930, all of which were originally taken near the mouth of the river (mostly within 2 miles) and were evidently coming in from the Mississippi. Five were retaken 1 day later at the same place at which they had been tagged. One was retaken 2 miles upstream 2 days after it had been released. Three were taken by a hook and line fisherman in a floodplain lake about 15 miles upstream 18 days after they had been tagged. One was retaken by another hook and line fisherman 28 miles upstream 63 days after it had been tagged. While these returns are too meager to warrant generalizations they do indicate that at this season bullheads are on the move and that they may travel considerable distances.

Bullheads are very hardy and can live under conditions other fishes cannot endure. They are omnivorous feeders. About one-fourth of their food is vegetable matter and the remaining three-fourths is made up mostly of aquatic insects, mollusks, crustaceans and other fishes. They spawn in May, June and July. Upon hatching, the young gather in a school and are guarded by the male.

Mud Cat; Goujon

Opladelus olivaris (Rafinesque)

Leptops olivaris (Rafinesque)

The mud cat or goujon is the second largest of our catfishes. Individuals weighing up to 60 pounds are reported by fishermen as not at all uncommon. This fish probably ranks next to the channel cat in the commercial catch of catfishes on this river. It is a good food fish, rated about the same as bullheads but not quite as high as channel cat or blue cat.

The mud cat seems to be present in considerable numbers from Sullivan to the mouth. All of our 55 specimens were taken in hoop nets except a single specimen, 4.5 inches long, taken in the minnow seine at Keyesport. These averaged 15 inches long and 11½ pounds in weight. If the numbers caught by our nets give a fair indication, mud cat is most abundant in the central portion of the stream, from Sullivan to Carlyle. Absence of young from the minnow-seine collections indicates that the mud cat does not breed extensively in this stream, unless it happens that the young are normally found in situations which we did not sample.

This fish feeds almost entirely upon other fishes. One weighing about a pound, taken in our hoop nets near Shelbyville, had in its mouth a long-eared sunfish about 4 inches long.

While not as characteristic of rapid water as the channel cat, it reaches its greatest abundance in the swifter Illinois streams. It moves along the edge of banks and eddies in the current rather than in mid-channel. During periods of low water some of the mud cats crawl into hollow logs and holes in the bank, and fishermen often take them from these holes with their hands or by hooking them through the jaw with a short stout hook.

We tagged 37 of the mud cats which we caught in the Kaskaskia. These varied from 7 to 26 inches in length and from .2 to 11 pounds in weight. Up to the present we have no returns from these fishes, but returns from other streams show rather extensive migrations.

Grass Pike.

Esox vermiculatus Le Sueur

The grass pike or little pickerel is the only representative of the pike family found in the Kaskaskia. Sixteen specimens were taken in our minnow-seine collections near the headwaters of the river. We have no record of the presence of this fish below Champaign county, though it probably occurs in tributaries entering farther down. It seems to be entirely carnivorous, with fish forming the bulk of its diet. Since it is a

rather small fish, seldom growing to a length of 12 inches, it is not of importance to the angler. It appears to be most abundant in quiet waters with plenty of vegetation in which it can hide and from which it can make dashes for its prey.

Wall-eyed Pike

Stizostedion vitreum (Mitchill)

Forbes and Richardson (1909) report the presence of wall-eyed pike, or pike-perch, in the Kaskaskia about 1900, but none have been taken in more recent collections. Fishermen along the middle reaches of the river stated that it was rarely taken.

Sauger

Cynoperca canadensis (C. H. Smith)

Stizostedion canadense griseum (DeKay)

Forbes and Richardson (1909) report the sauger as occurring in the Kaskaskia in former years, but we failed to obtain it in our collections.

Large-mouth Black Bass

Huro salmoides (Lacépède)

Micropterus salmoides (Lacépède)

The large-mouth black bass was not found in the channel of the Kaskaskia. It shows a preference for lakes, bayous and quiet waters, and is common in the overflow ponds and floodplain lakes of the Kaskaskia valley, since many of the brood fish in the Carlyle hatchery were obtained there.

Its food consists mainly of fishes and crayfish, with a few mollusks and insects. According to Evermann and Clark (1920) it feeds to some extent all winter, being caught in considerable numbers through the ice on Lake Maxinkuckee. It is a sportsman's fish and its propagation in artificial ponds for liberation in public waters has reached a high degree of development. Its flesh does not compare favorably with the best, such as wall-eyed pike, bluegill and channel cat, but it is a fair food fish and is highly esteemed by many. It reaches a maximum weight of 8 or 10 pounds in this latitude.

Small-mouth Black Bass

Micropterus dolomieu Lacépède

The small-mouth black bass is represented in our study by 15 young

specimens taken with the minnow seine in the vicinity of Shelbyville, Cowden and Vandalia. While we failed to obtain adult individuals, fishermen report that during periods of clear water small-mouth bass are caught in stretches of the river from Shelbyville to Sullivan and for some distances above and below these points. This species shows a preference for clear swift water, in contrast to the large-mouth bass which prefers quiet water. Its food consists for the most part of fish and crayfish, with a few insects and mollusks.

This is a good food fish, slightly better than the large-mouth bass but somewhat inferior to the best grades of fresh-water fishes. For gameness it has a reputation even better than that of the large-mouth bass, and for this reason it is a favorite of sportsmen. It reaches a length of 15 to 20 inches and a maximum weight of 6 pounds.

The small-mouth bass may be separated from the large-mouth by the inferior size of its mouth and by the greater number of its scales. The posterior end of the upper jaw usually does not extend beyond the posterior border of the eye, while in the large-mouth bass it extends beyond this point. The number of rows of scales on the cheek is about 17, while in the large-mouth the number is only ten or 11.

Green Sunfish

Apomotis cyanellus (Rafinesque)

Lepomis cyanellus Rafinesque

The green sunfish is quite widely distributed in the Kaskaskia but it is not very abundant in any one locality. Thus 33 specimens were taken from 11 localities between Giblin near the headwaters and Nine Mile Creek near the mouth of the river. This is an excellent pan fish when large enough. It feeds mainly on insects, crustaceans and fishes.

Orange-spotted Sunfish

Allotis humilis (Girard)

Lepomis humilis (Girard)

This beautiful little fish is represented in our collections by 481 individuals, 464 of which came from one locality near Vandalia and the rest from three other places. Thus it is likely to appear abundantly in one situation and be entirely absent from the same sort of habitat a few miles away. Seldom more than 3½ inches long, it is too small to be valuable as a food fish, and it may be considered a "weed" since it consumes food that may be useful to larger fishes.

Long-eared Sunfish

Xenotis megalotis (Rafinesque)

Lepomis megalotis (Rafinesque)

The long-eared sunfish occurs very abundantly in the clearer swifter parts of the Kaskaskia in Douglas, Coles, Moultrie and Shelby counties. We did not find it in the river below Shelbyville. Of the 164 specimens taken 137 were adults, 23 of the largest of which were tagged before being released. This species is especially abundant near Sullivan, where we took 33 in one night in a 30-inch hoop net.

This species is a good pan fish but it is usually too small to be of much use for food. Our largest individuals were slightly over 5 inches long and weighed between 2 and 3 ounces.

Bluegill

Helioperca incisor (Cuvier & Valenciennes)

Lepomis pallidus (Mitchill)

The bluegill was taken by us in but two localities. Three young individuals were taken with the minnow seine at Sullivan and one adult with the hoop net near the mouth of the river. It is so rare in the Kaskaskia that it is of very little importance.

Of all the sunfishes the bluegill is the largest and best from a food standpoint. According to Forbes and Richardson (1909), it reaches a length of 12 inches and a weight of 11½ pounds. It has excellent table qualities and in recent years has become a favorite with large numbers of fly fishermen.

It prefers pond and lake waters but is common also in the larger rivers. It is an omnivorous feeder, sometimes subsisting entirely on vegetation, sometimes on insects, mollusks and other available animal food. Evermann and Clark (1920) state that it does not feed on other fishes, but Forbes and Richardson (1909) found the body of one darter in the stomach of a bluegill.

Warmouth Bass

Chaenobryttus gulosus (Cuvier & Valenciennes)

One specimen of the warmouth was taken while we were seining for bait in a floodplain slough 3 miles below Carlyle. This species is most at home in the turbid waters of muddy lakes and sloughs, in contrast to the rock bass which prefers swift clear streams. It grows to a length of 10 inches and is a fair angler's fish, but its flesh often has a muddy flavor.

Rock Bass

Ambloplites rupestris (Rafinesque)

The rock bass is represented in our collections by 23 specimens taken from four localities, of which 19 were adults taken at Sullivan and Shelbyville. These adults averaged $7\frac{1}{4}$ inches long and weighed .4 of a pound (Fig. 10). Two young were taken at Vandalia and two at Venedy Station. Seventeen adults were tagged and released.

This fish shows a preference for swifter parts of the stream where the water is clear. It also occurs in clear, moderately deep lakes but is not so abundant in shallow warm waters. Our data indicate that it is limited to a rather restricted part of the Kaskaskia basin in Coles, Moultrie and Shelby counties where the river is not yet large and where the current is somewhat swifter than in the lower reaches.

The rock bass feeds mainly on insects, crustaceans and fishes. It is a good pan fish and attains a length of 12 inches and a weight of $1\frac{1}{2}$ pounds, though the average is about $\frac{1}{2}$ pound. It usually spawns in May and June. It will bite on almost any kind of animal substance, perhaps the best baits being small minnows, white grubs, grasshoppers, hellgramites and earthworms.

White Crappie

Pomoxis annularis Rafinesque

The white crappie is probably the most abundant game fish of the Kaskaskia. We took 72 adults and 17 young from ten localities ranging from Sullivan to the mouth of the river. All were caught in the main channel. We found no young in the river above Vandalia. Forty of the adults were tagged and released but no returns from them have been received. The adults averaged $7\frac{1}{4}$ inches in length and weighed from 2 to 10 ounces.

Age determinations made on 61 white crappies taken at various points on the Kaskaskia River and of sizes commonly taken on hook and line were distributed as follows: one individual was in its second summer of growth, 37 were in their third summer, 18 in their fourth summer and five in their fifth summer. The lengths of crappies of different ages in the Kaskaskia have been given in the Introduction to this report.

The white crappie, on account of its abundance and table qualities, is one of the most important of the sunfishes. It is successfully propagated in hatcheries and is one of the best of fishes for stocking artificial ponds, especially those which fluctuate in level and tend to be turbid. It has a wide range of adaptability and occurs most abundantly in larger streams

and quiet waters such as lakes and ponds. Its food consists entirely of animal material and is mostly insects, crustaceans and small fishes. It takes the bait readily especially if small live minnows are used.

Black Crappie

Pomoxis sparoides (Lacépède)

The black crappie or calico bass is much less common in the Kaskaskia than is the white crappie. Only ten specimens from six localities were taken in our nets. These localities, however, were spread the length of the river, from Sullivan to the mouth. Nine of these fishes were tagged and released. Besides the difference in coloration this crappie may be separated from the white crappie by its comparatively greater depth of body and by the number of spines in its dorsal fin, which is usually seven or eight instead of six as in the white crappie.

The general range of the black crappie extends farther northward than that of the white crappie, but not as far south. In feeding habits it is much like the white crappie, and for this reason is caught by the same methods. Both white and black crappies usually spawn in May.

Sheepshead; Drum

Aplodinotus grunniens (Rafinesque)

The sheepshead, drum or white perch forms a considerable part of the commercial catch of the fishery of the Kaskaskia. In 1922, according to the United States Bureau of Fisheries (Sette, 1925), the catch of this species was 5,200 pounds and was valued at \$640. This was more than one-sixth of the total commercial catch in that year.

Our five specimens were taken at three localities—Vandalia, Carlyle and New Athens. Hook and line fishermen report that the sheepshead is common as far up the river as Shelbyville.

The sheepshead is notable for its powerful pharyngeal jaws and millstone-like teeth by means of which it is able to crush the shells of many fresh-water mollusks. Because of its food relation to the mussels it becomes heavily loaded with their glochidia, which, after a short period of parasitic existence, drop to the river bed and develop into adult mussels. Thus, in some measure, it pays for its food by nourishing the young of the mussels and at the same time carrying them over wide areas and finally dropping them where they may develop and in turn serve it as food.

This fish receives its common name, drum, from the peculiar drumming sound it makes. This sound is believed to result from the rapid contraction of two bands of muscles that set up vibrations in the wall of the air bladder, which thus acts as a resonator.

There are differences of opinion as to the quality of the flesh of this fish for food. Large drums are said to be very inferior in quality, becoming stringy and unpalatable with age, but the small drums have a good flavor and a ready sale. The hook and line fishermen of the Kaskaskia consider the drum of that stream to be a fine pan fish. The flesh is somewhat more oily than that of other Illinois game fishes. According to Coker (1929), drums from the inland lakes of Minnesota and Wisconsin are very inferior in quality and are of no value as food, while those of Lake Keokuk and Lake Pepin are usually considered good.

Little is definitely known concerning the breeding habits of this fish. Fry $\frac{3}{4}$ -inch to 2 inches long were taken in the Sangamon River, both above and below the Decatur dam, between July 18 and July 30 in 1929. Fry $\frac{1}{2}$ to $1\frac{1}{2}$ inches long were seen on sand bars of the Mississippi along the Chester water front August 1, 1930. The size of these fry would indicate that in this latitude the breeding season is in June, perhaps extending into July.

The drum grows to a large size, attaining a weight of 50 to 60 pounds. Such large individuals, however, are unusual and almost unknown now, and most of those caught in the Kaskaskia weighed from $\frac{1}{2}$ pound to 3 pounds, with only occasional individuals weighing 10 pounds or more.

It will take a wide variety of animal baits and will bite on spinners and spoonhooks. It may be considered a game fish in the Kaskaskia.

SMALL FISHES

The Minnows

Native minnows of the Kaskaskia are small scaled fishes with a single dorsal fin. A few kinds may occasionally reach an extreme length of 8 or 10 inches, but we usually think of them as not exceeding a finger's length. They are a staple in the diet of our large carnivorous game fishes and are everywhere a favorite bait. Most kinds of minnows feed primarily on insects and small crustaceans, with a few others feeding on plant material, and still others feeding on organic detritus from the bottoms of our ponds and streams. Of the 8,540 fishes of all kinds taken by various methods in the course of this survey, 6,276 were minnows.

In the following list of species the number of collections in which each kind occurred is given, as well as the total number of specimens of each kind.

Notemigonus crysoleucas (Mitchill). [*Abramis crysoleucas* (Mitchill)].—**Golden shiner.** 13 colls. 120 spms.

This excellent bait minnow reaches a length of 6 to 8 inches. Most of the specimens were taken in the headwaters of the Kaskaskia with smaller numbers in the lower reaches of the main channel. It is found most numerous where the water is quiet and about aquatic vegetation or other cover. It spawns from May until August. The golden shiner has come into prominence in recent years as a forage fish in the propagation of bass, crappies and bluegills in ponds.

Opsopoeodus emiliae Hay.—**Snub-nosed minnow.** 2 colls. 3 spms. Length, $2\frac{1}{4}$ inches.

Semotilus atromaculatus (Mitchill).—**Horned dace.** 14 colls. 217 spms. Common in the Kaskaskia basin. Most abundant in the smaller tributaries. It grows to 6 or 8 inches in length and is a fine and hardy bait fish. Ripe females and males were found in May, 1930, and the eggs were readily stripped and fertilized by milt from the males.

Notropis atherinoides Rafinesque.—**River shiner.** 6 colls. 285 spms. This long slender minnow is found most abundantly in larger rivers and lakes. In the Kaskaskia it occurs from Vandalia to the mouth. It reaches a length of $2\frac{1}{2}$ to $4\frac{1}{2}$ inches and is often used as bait.

Lythrurus umbratilis cyanocephalus (Copeland). [*Notropis umbratilis atripes* (Jordan)].—**Blackfin minnow.** 12 colls. 195 spms. Common in the tributaries of the Kaskaskia and in the main channel as far downstream as Shelbyville. Length, 3 inches.

Luxilus cornutus (Mitchill). [*Notropis cornutus* (Mitchill)].—**Common shiner.** 17 colls. 516 spms. Found in the creeks of the Kaskaskia basin, abundant in tributaries in Champaign county. Length, 5 to 8 inches. It is our most important bait fish since it can be transported easily and is active and lives well on the hook. It spawns in May and June, depositing its eggs in the nests of other nest-building fishes such as the Kentucky chub and the horned dace.

Luxilus cornutus (Mitchill) $\times$ *Nocomis biguttatus* (Kirtland).—**Hybrid.** 2 colls. 7 spms. Identified by Dr. Carl L. Hubbs. Formerly designated as *Notropis pilsbryi* Fowler.

Luxilus cornutus (Mitchill) × *Hybognathus nuchalis* Agassiz.—**Hybrid**.
1 coll. 1 spm.

Identified by Dr. Carl L. Hubbs.

Cyprinella whipplii (Girard). [*Notropis whipplii* (Girard)].—**Silverfin**.
19 colls. 1041 spms.

Very abundant in the Kaskaskia from Parkville to the mouth. This is characteristically a swift-water minnow and makes excellent bait. Length, 3 to 4 inches. Spawns in summer, May to August.

Cyprinella lutrensis (Baird & Girard). [*Notropis lutrensis* (Baird & Girard)].—**Redfin**.

Reported by Forbes and Richardson (1909) from the Kaskaskia. Length, 2 to 3 inches.

Hybopsis hudsonius (De Witt Clinton). [*Notropis hudsonius* (De Witt Clinton)].—**Spot-tailed minnow**.

Reported by Hankinson (1913) from Crabapple Creek, in Coles county. Length, 4 to 6 inches.

Hybopsis deliciosus (Girard). [*Notropis blennius* (Girard)].—**Straw-colored minnow**. 16 colls. 248 spms.

Common throughout the Kaskaskia. Length, 2½ inches.

Hybopsis blennius (Girard). [*Notropis jejunus* (Forbes)]. 1 coll. 50 spms.

Length, 2 to 2½ inches.

Hybopsis boops Gilbert. [*Notropis illecebrosus* (Girard)].—**Big-eyed minnow**. 2 colls. 12 spms.

Taken near Sullivan. Length, 3 inches.

Platygobio gracilis (Richardson).—**Flat-headed chub**. 1 coll. 12 spms.

Found in lower reaches of the Kaskaskia. Length, 10 to 12 inches.

Nocomis biguttatus (Kirtland). [*Hybopsis kentuckiensis* (Rafinesque)].—**Hornyhead; Kentucky chub**. 13 colls. 446 spms.

Abundant in headwaters of the Kaskaskia in Champaign county. Since the hornyhead grows to 8 or 10 inches in length fly fishermen sometimes find good sport whipping for it on riffles in clear creeks. Spawning begins in late May and early June, and extends into August.

Erinemus storerianus (Kirtland). [*Hybopsis storerianus* (Kirtland)].—**Storer's chub**. 5 colls. 71 spms.

One of the largest of our native minnows found in larger rivers and lakes. In the Kaskaskia it was found as far upstream as Cowden. It grows to a length of 10 inches and spawns in June and July.

Erinemus hyalinus Cope. [*Hybopsis amblops* (Rafinesque)].—**Big-eyed chub.** 6 colls. 45 spms.

Taken in the Kaskaskia at Sullivan and points further downstream. Length, 2 to 3 inches.

Erimystax dissimilis (Kirtland). [*Hybopsis dissimilis* (Kirtland)].—**Spotted shiner.**

Reported from the Kaskaskia by Forbes and Richardson (1909). Length, 3 inches.

Macrhybopsis gelidus (Girard). [*Hybopsis gelidus* (Girard)]. 1 coll. 1 spm.

Taken with beam trawl 2 miles above the mouth of the Kaskaskia. Length, 3 inches. Jordan (1929) states that it is a species of large river channels.

Extrarius hyostomus (Gilbert). [*Hybopsis hyostomus* (Gilbert)]. 1 colls. 39 spms.

All taken in a beam trawl at one locality $1\frac{1}{2}$ miles above the mouth of the river. This species is very small, seldom reaching $1\frac{3}{4}$ inches in length.

Ericymba buccata (Cope).—**Silver-mouthed minnow.** 18 colls. 526 spms.

Taken in small numbers in the headwaters of the Kaskaskia and in the lower reaches of the main channel usually over sand and gravel bottom. It spawns in April and May. Length, 3 to 4 inches.

Phenacobius mirabilis (Girard).—**Sucker-mouthed minnow.** 8 colls. 81 spms.

A minnow which prefers creeks and small rivers where it is found on the swiftest riffles. Length, $3\frac{1}{2}$ inches. It spawns in late May and early June.

Hybognathus nuchalis Agassiz.—**Silvery minnow.** 22 colls. 785 spms.

A large pale minnow common in the Kaskaskia basin. It is so soft and sensitive that it is unsuitable for bait.

Ceraticthys vigilax Baird & Girard. [*Cliola vigilax* (Baird & Girard)].—**Bullhead minnow.** 13 colls. 428 spms.

Common in larger rivers, occurring between Sullivan and the mouth in the main channel of the Kaskaskia. Length, 2 to 3 inches. Breeding season in late May and early June.

Hyborhynchus notatus (Rafinesque). [*Pimephales notatus* (Rafinesque)].

—**Blunt-nosed minnow.** 28 colls. 1069 spms.

The most widely distributed and abundant minnow of the Kaskaskia. Adults 2 to 3½ inches in length. A very common bait minnow. It begins spawning in late May and early June, the season extending into late summer.

Pimephales promelas Rafinesque.—**Fathead minnow; black-head minnow.** 4 colls. 11 spms.

Found occasionally in the channel of the Kaskaskia. Length, 2½ inches. Spawning season extends throughout the summer. This minnow is coming into use as a forage fish in the pond culture of game fishes. It is also well adapted for laboratory use since a few ripe eggs can be stripped from breeding females each day over long periods and fertilized by milt stripped from males.

Camptostoma anamolum (Rafinesque).—**Stoneroller; doughbelly.** 2 colls. 24 spms.

An excellent bait minnow reaching a length of 6 inches. Breeds from March until May. Breeding males covered with tubercles. Common in creeks and small rivers with swift water and rocky or gravelly bottom. Scarce in the Kaskaskia basin.

The Stonecats

These little catfishes present the same general appearance as their larger relatives. They are unique, however, in that they are equipped with poison glands and can inflict extremely painful wounds with their spines.

Noturus flavus (Rafinesque).—**Stonecat.**

Reported from the Kaskaskia by Forbes and Richardson (1909).

Schilbeodes gyrinus (Mitchill).—**Mad Tom; tadpole cat.** 1 coll. 4 spms.

Taken at one locality near the mouth of the river. Forbes and Richardson's data show that it formerly was common in this river. Length, 3 to 5 inches.

Schilbeodes nocturnus (Jordan & Gilbert).—**Freckled stonecat.** 3 colls. 10 spms.

From Vandalia, Keyesport and Venedy Station in the middle reaches of the river. Habitat characterized by very swift water with rocky or sandy bottom. Length, not over 3 inches.

Rabida exilis (Nelson). [*Schilbeodes exilis* (Nelson)].—**Slender stonecat.** 1 coll. 1 spm.

Taken near Sullivan. Length, 3 to 4 inches.

Rabida miurus (Jordan). [*Schilbeodes miurus* (Jordan)].—**Brindled stonecat.**

Reported from the headwaters of the Kaskaskia by Forbes and Richardson (1909). Length, 3½ inches.

The Darters

The darters are small scaled fishes with two dorsal fins, and are usually strikingly marked with bars and blotches. Breeding males are very highly colored and exhibit brilliant greens, blues, reds and blacks. They habitually rest on the bottom and move by crawling with their fins, or by swift dashes. Most kinds are to be found hiding under and among rocks and other cover on the riffles of brooks and creeks.

While they eat insects and other animal food almost exclusively they are relatively insignificant in the economics of our waters, since they are very small both in size and numbers.

Percina caprodes (Rafinesque).—**Log perch.** 2 colls. 2 spms.

One taken near Bondville and another at Vandalia. Thirty or more years ago Forbes and Richardson found it common in the headwaters of the Kaskaskia. This is the largest of the darters, occasionally exceeding 6 inches in length.

Alvordius phoxocephalus (Nelson). [*Hadropterus phoxocephalus* (Nelson)].—**Sharp-nosed darter.** 5 colls. 73 spms.

Common in the middle reaches of the Kaskaskia from Sullivan to Carlyle. Length, 3 inches. Most numerous in swift waters of larger creeks and small rivers with a sandy or rocky bottom.

Alvordius maculatus Girard. [*Hadropterus aspro* (Cope & Jordan)].—**Black-sided darter.** 7 colls. 11 spms.

From seven localities between Ivesdale and Vandalia. Length, 3 to 4 inches.

Ericosma evides (Jordan & Copeland). [*Hadropterus evides* (Jordan & Copeland)]. 1 coll. 1 spm.

Collected near the mouth of the Kaskaskia. Length, 3 inches.

Imostoma shumardi (Girard). [*Cottogaster shumardi* (Girard)].

Reported by Forbes and Richardson (1909) from two localities on the Kaskaskia.

Boleosoma nigrum (Rafinesque)—**Johnny darter**. 21 colls. 136 spms.
Very widespread and abundant in the Kaskaskia basin, though not found in the main course of the river below Vandalia. It shows a preference for creeks and brooks. Length, $2\frac{1}{2}$ inches. Breeding usually in May and June.

Vaillantia camura (Forbes). [*Boleosoma camurum* (Forbes)].—**Snub-nosed darter**. 7 colls. 83 spms.

Common in the channel of the Kaskaskia below Cowden. Length, $1\frac{3}{4}$ inches.

Vigil pellucidus (Baird). [*Ammocrypta pellucida* (Baird)].—**Sand darter**. 9 colls. 47 spms.

Common in the main course of the river from Shelbyville to Venedy Station. Has the habit of burying itself in sand with all but its head covered. Length, $2\frac{1}{4}$ inches.

Oligocephalus coeruleus (Storer). [*Etheostoma coeruleum* Storer].—**Rainbow darter**. 1 coll. 9 spms.

Taken only in Reilly Lake Creek which joins the Kaskaskia near its mouth. Length, $2\frac{1}{2}$ inches. The male of this species is very brilliantly colored in reds and blues.

Oligocephalus jessiae (Jordan & Brayton). [*Etheostoma jessiae* (Jordan & Brayton)]. 2 colls. 2 spms.

One collected at Keyesport and another in Nine Mile Creek. Length, 2 inches.

Catnotus flabellaris (Rafinesque). [*Etheostoma flabellare* Rafinesque].—**Fantail darter**.

Reported by Forbes and Richardson (1909) from the Kaskaskia near Cowden. Length, $2\frac{1}{2}$ inches.

Hololepis fusiformis (Girard). [*Boleichthys fusiformis* (Girard)]. 2 colls. 14 spms.

Taken at two localities near the mouth of the river. Forbes and Richardson (1909) formerly reported it from several localities in the middle course of the Kaskaskia. Length, 2 to $2\frac{1}{2}$ inches.

Miscellaneous Small Fishes

Zygonectes notatus (Rafinesque). [*Fundulus notatus* (Rafinesque)].—**Top minnow**. 11 colls. 58 spms.

Common throughout all parts of the Kaskaskia. Length, 2 to 3 inches. Probably spawns in June.

Gambusia patruelis (Baird & Girard). [*Gambusia affinis* (Baird & Girard)].—**Viviparous top minnow.** 5 colls. 60 spms.

Common in the Kaskaskia from Vandalia to Venedy Station. Length, 1½ to 2 inches. Males fewer than females. Eggs held within body of female until young are well developed. Several broods in a season.

Aphredoderus sayanus (Gilliams).—**Pirate perch.** 6 colls. 106 spms.

Abundant in the headwaters of the Kaskaskia in Champaign county. Prefers streams with considerable aquatic vegetation in which to hide. Length, 4 inches. Anus at throat. Its food is made up mainly of animal material, fishes forming a small proportion, with insects making up the bulk. The breeding season is in May.

Labidesthes sicculus Cope.—**Brook silverside.** 2 colls. 3 spms.

Two specimens were taken at Venedy Station and one 3 miles south of Carlyle. Length, 3 inches.

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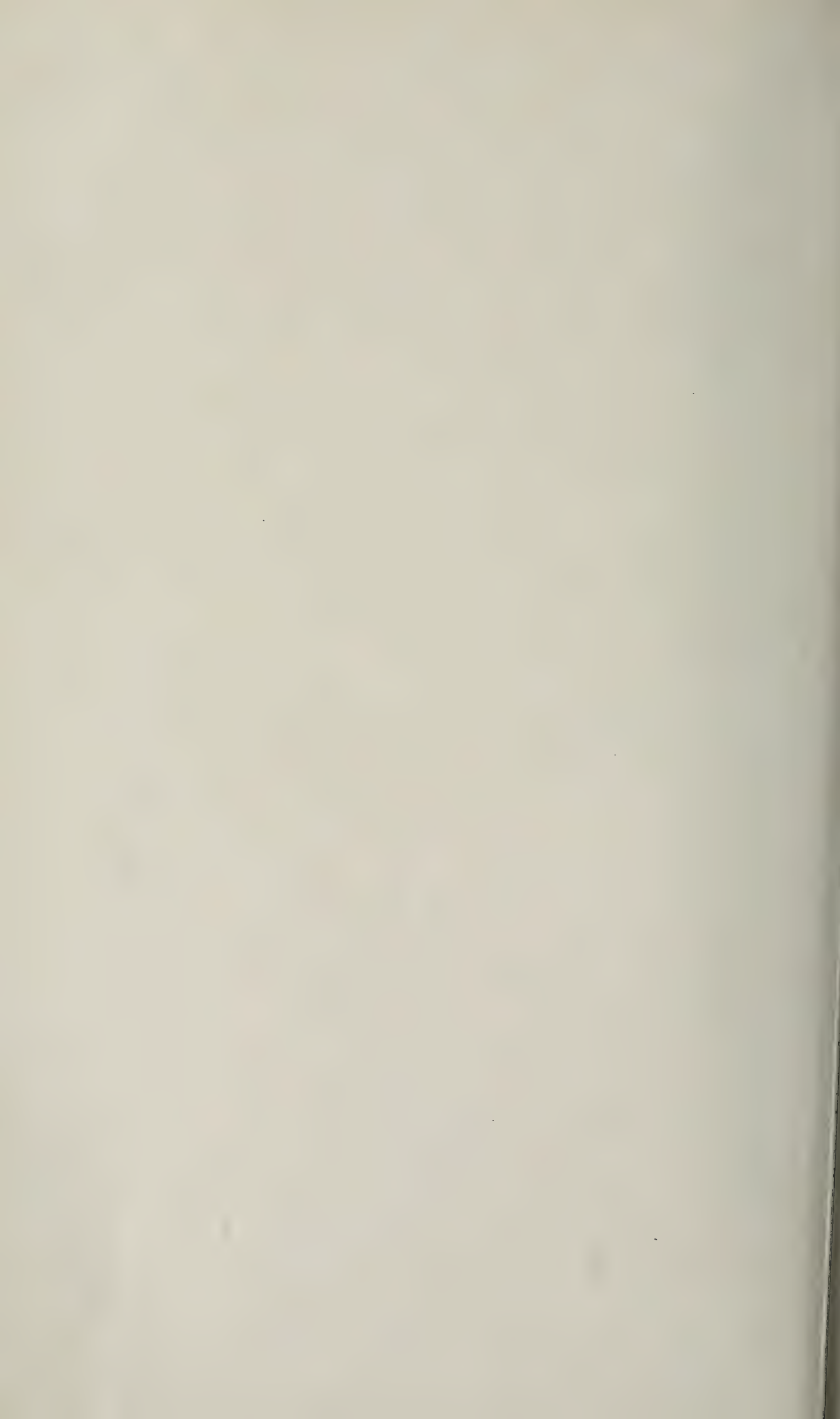
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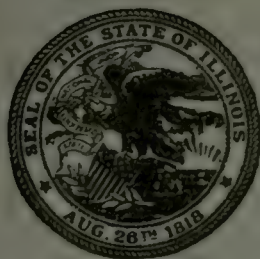
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Article III

The
Dermaptera and Orthoptera
of Illinois

MORGAN HEBARD



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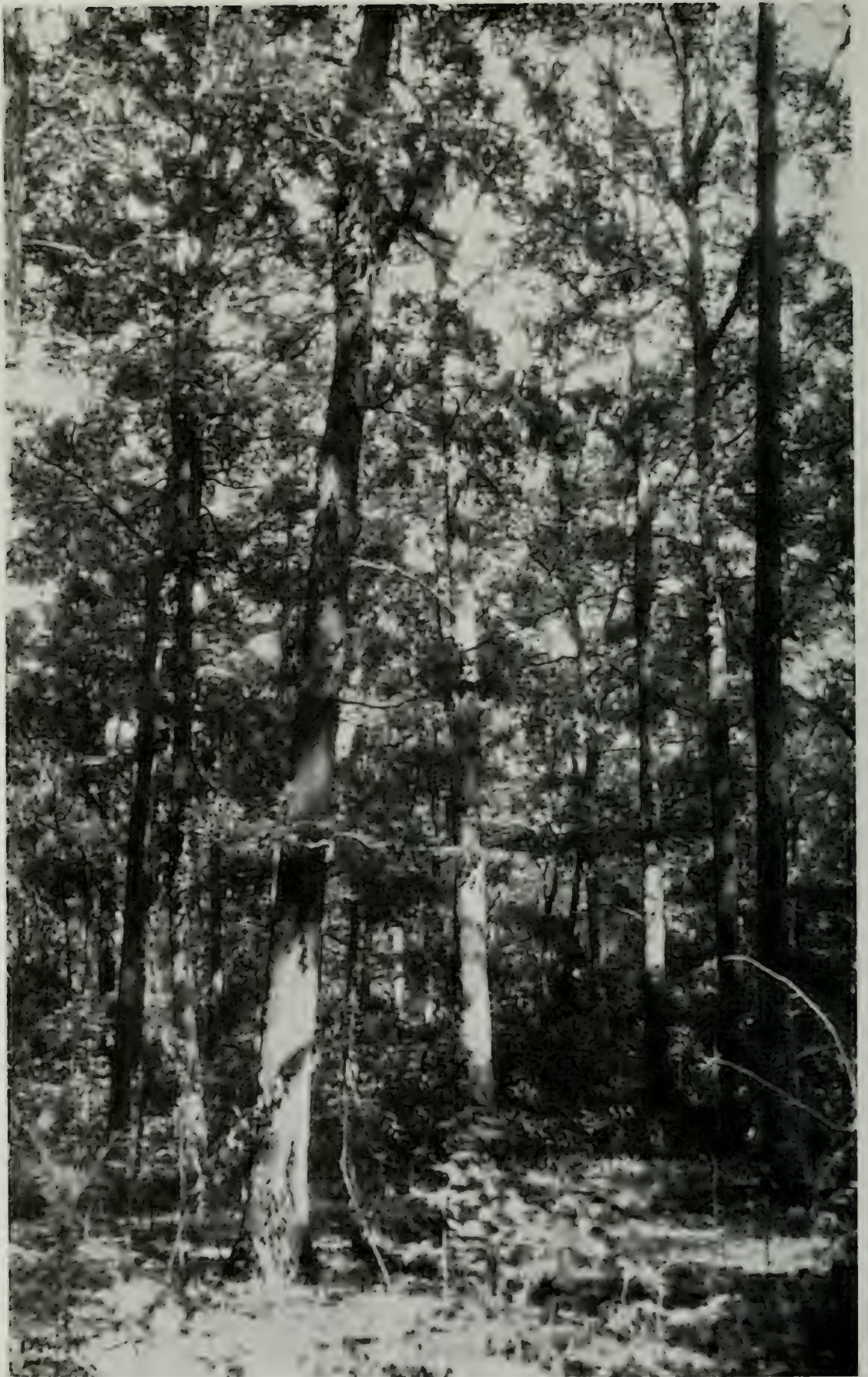
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CONTENTS

	PAGE
Biology and Habits of the Orders.....	125
General resemblance of life cycles.—Orthoptera feeding habits vary widely.	
—Ovipositing methods equally varied.	
Ecological Factors Affecting Orthoptera.....	128
Surprising variety of habitats in the state.—Prairie.—Sand areas.—	
Swampy areas.—Shrubby places.—Forest.—Cypress bottoms.	
Summary of Literature.....	134
Thomas.—McNeill.—Hart and Vestal.—Blatchley.	
Collection and Disposition of the Material.....	135
Localities.—Present holders of material: symbols.—Map of Illinois.	
Use of the Keys.....	140
Glossary.—Plates I–IV illustrating keys.	
Key to the Orders.....	150
Plate V differentiating orders.	
Dermaptera.....	151
Orthoptera.....	151
Bibliography.....	259
Appendix.....	266
Grasshopper control.—Cockroach control.—Index to subfamilies, genera and species.	



The floor of this upland oak-hickory woods south of Olney, Illinois, is a typical habitat of *Melanoplus viridipes viridipes*, *Hapithus agitator* and *Ceuthophilus maculatus*. (Photo by U. S. Forest Service.)

The Dermaptera and Orthoptera of Illinois

MORGAN HEBARD¹

BIOLOGY AND HABITS OF THE ORDERS²

THE ORTHOPTERA first attract one's attention because of their universal presence and relatively large size. In the warmer parts of the year every woodland and field, roadside and garden harbors numbers of the larger and more conspicuous grasshoppers and crickets which leap or fly from one's path. Some are very drab and sullen creatures, but others flash brilliantly colored wings or crackle stridently through the air. A closer acquaintance however discloses that these bold forms which first catch the eye are no more interesting than a host of their allies, the grouse locusts, walking sticks, katydids and others, who hide away in their surroundings and must be sought with care and patience. It is among these that we find not only the fanciful and bizarre forms, but also the finest assemblage of musicians produced by the insects. The male members of the crickets and katydids keep the late summer and autumn nights fairly alive with song, each with his own particular note or line, the whole mingling to form a really charming chorus.

From the evolutionary standpoint of the insects as a whole, the Orthoptera and Dermaptera are generalized groups lacking many of the specializations in anatomy and development possessed by other orders. They have however followed many lines of development within their own orders, resulting at the present in a startling array of diverse shapes and habits.

¹Research Associate, Department of Entomology, Academy of Natural Sciences of Philadelphia.

²This section and the one following on ecology were written by H. H. Ross, systematic entomologist, ILLINOIS STATE NATURAL HISTORY SURVEY. The material on the Rhaphidophorinae, p. 220, is the work of T. H. Hubbell of the Department of Biology, University of Florida. W. P. Flint, chief entomologist, ILLINOIS STATE NATURAL HISTORY SURVEY, contributes the section on control measures, p. 266.

GENERAL RESEMBLANCE OF LIFE CYCLES

In their general features all Orthopteran and Dermapteran life histories are essentially the same, in that the young insects hatching from the eggs are miniature replicas of the adults, differing in their size and the absence of wings and reproductive organs. The wings and certain other sets of characters are developed gradually with successive moults until they are complete and ready for use when the full grown nymphs mature into adults. This gradual type of development is known as *incomplete metamorphosis*. Contrasted with it is *complete metamorphosis*, in which the successive life history stages form at least three distinct and dissimilar types—larva, pupa and adult. This is exemplified by the moths and butterflies, whose first stages are wormlike and known as larvae; these larvae feed until full grown, then change into an inactive resting form called the pupa; from this pupa the adult insect emerges, entirely different in appearance from either the larva or pupa.

The Dermaptera pass the winter in the adult stage, whereas most of the Illinois Orthoptera pass the winter in the egg stage, especially in the northern portion of the state. There are however exceptions to this, most conspicuously in the case of the grouse locusts and the common grasshopper *Chortophaga viridifasciata*, which hibernate as adults and nymphs respectively.

In Illinois cockroaches living in dwellings or other heated structures have a series of generations throughout the year, resulting in several to many annually. The general rule however is that the outdoor members of the two orders usually have only one brood a year.

ORTHOPTERA FEEDING HABITS VARY WIDELY

The various members of the Orthoptera exhibit a great variety of feeding habits, being either omnivorous, herbivorous or predaceous. The grouse locusts and grasshoppers (Acrididae) and the katydids (Tettigoniidae) are almost entirely herbivorous, feeding on grasses, herbs and to some extent on shrub and tree foliage. Some of the walking stick insects (Phasmidae) feed on the foliage of almost all the deciduous trees, showing some preference for oak and wild cherry; others feed upon prairie plants. Interesting among the herbivorous Tettigoniidae are the members of the genus *Camptonotus*, which make a nest by rolling together the leaves of the bladder nut or other trees. The sand crickets (Gryllotalpinae and Tridactylinae) eat the roots of plants, among which they burrow.

A considerable number of Orthoptera are omnivorous, eating carrion, dung, herbs, etc.; most prominent among these are the ground and field crickets (Gryllinae), the shield bearers (Decticinae), cave and camel crickets (Rhaphidophorinae) and the cockroaches (Blattidae). The tree crickets (Oecanthinae) are more or less omnivorous, feeding upon a variety of soft

foods such as scale insects, aphids, fruits and tender leaves. The mantids are aggressively predaceous, feeding upon many kinds of insects which they capture in their grasping front legs. The myrmecophilous Orthoptera (Myrmecophilinae) are a curious group living in ant nests. They feed on the epidermal secretions of the ants.



Fig. 1.—Prairie composed of *Andropogon scoparius* and prairie herbs near Savanna, Illinois. Habitat of such grasshoppers as *Syrbula admirabilis*, *Hippiscus rugosus* and *Encoptolophus sordidus*. *Arphia sulphurea* usually occurs in shorter grass with a denser sod. *Neoconocephalus ensiger* occurs in similar situations in certain localities. (After Sampson, ILL. NAT. HIST. SURV. BUL., vol. XIII, art. XVI.)

The Dermaptera or earwigs are more or less omnivorous, being herbivorous to some extent, but performing mostly as scavengers.

OVIPOSITING METHODS EQUALLY VARIED

The egg laying habits within the Orthoptera exhibit diversifications ranging from a simple type to a highly specialized one. The walking sticks have the simplest method, dropping the eggs indiscriminately on the forest floor. The crickets insert their eggs irregularly into rotten wood, bark or the soil. The snowy tree crickets show considerable care in egg laying—the female makes a small hole in a branch of a tree, deposits the egg in the bottom and covers it first with a mucilaginous secretion and then with chewed-up bark. The meadow katydids and coneheads deposit their eggs in the sheathes of grass stems and similar places.

The katydids lay flat oval eggs, arranged in single rows along the twigs or under the edges of leaves, forming a very pretty arrangement. Mantids cement the eggs in weatherproof masses on upright stems or branches of shrubs and trees, each mass containing 20 to 40 eggs. The grouse locusts also deposit their eggs gregariously, making furrows in the soil and placing 10 to 30 eggs in each. This is an interesting type intermediate between the methods found in the crickets and the grasshoppers. The most highly specialized type of oviposition in the soil is shown by the grasshoppers. They insert the abdomen almost its full length downward into the soil and lay the eggs one by one into the pocket thus formed. The eggs are laid carefully in order, until a neat mass of 30 to 60 is formed. Over them a mucilaginous and waterproof substance is secreted, which binds them together in a bundle. The opening of the egg cavity in the soil is then plugged up by the mother with a mixture of earth and the same mucilaginous secretion, which forms a waterproof cap.

The cockroaches have probably the most specialized egg laying method of the entire order. The eggs are united into a somewhat elongate oblong capsule, or oötheca, which frequently remains attached to the end of the mother's abdomen until nearly time for hatching.

The Dermaptera lay their eggs in a pile at the end of a burrow in the ground. The mother tends the eggs with diligence until they hatch, and soon afterward abandons the young. This maternal care of the eggs is extraordinary for an insect.

ECOLOGICAL FACTORS AFFECTING ORTHOPTERA

IN ILLINOIS the distribution of the various species of Orthoptera is apparently determined by soil, cover and climate. In many other groups of phytophagous insects the distribution of the insect species is dependent primarily on the distribution of the food plant. This is not true of the Orthoptera, probably with a few exceptions, such as *Inscudderia taxodii* which is always found upon cypress. Even in this case however the insect may not actually feed upon the cypress foliage. The larger number of Orthoptera are distributed in Illinois according to the general type of vegetation, such as forest, shrubbery, prairie or marsh. Each of these supports species not found in the others. Of the soil types found in the state, pure sand is the only one with a markedly distinct fauna not occurring on other soils. There is of course considerable overlapping between related habitats. The prairie species, for instance, occur mixed with sand species on sand with a moderate cover of grass. A considerable number of the meadow katydids and other Orthoptera occur in both prairie and swampy situations. An interesting example of latitude of requirements is shown

in the case of *Dichromorpha viridis*, which is found in damp woods, prairie and swamp.



Fig. 2.—UPPER.—Sand dunes at Havana, Ill. Habitat of *Melanoplus angustipennis*, *Ageneotettix deorum*, *Spharagemon collare* and *Psinidia fenestralis*. (Photo by Vestal.) LOWER.—Sand blow-out at Havana. The bare sand is the habitat of *Melanoplus flavidus*; the areas of tall sand plants contain *Schistocerca alutacea*. (After Vestal, Bul. Ill. State Lab. Nat. Hist., vol. X, art. I.)

The effect of climate is shown by the northern or southern restriction in the state of a number of Orthoptera. A considerable proportion of the species is found, or is likely to be found, over the entire state. Some other

species however are obviously limited in their northern or southern distribution. The southern forms give the impression of a wave of species fading out at individual boundaries without a segregation into definite faunal zones. Thus *Neotettix femoratus* and *Montezumina modesta* have been taken in the state only rarely, at the extreme southern tip; *Inscudderella taxodii* is limited to the southern floodplain; *Orocharis saltator* extends over this through the Ozark hills; *Melanoplus ponderosus viola* has been taken in the Ozarks and slightly northward; and such forms as *Hapithus agitator*, *Miogryllus verticalis* and *Amblycorypha uhleri* extend farther north, sometimes into the central portion of the state.

There is a similar wave of species entering the state from the north, east and west. They demonstrate the axial position of Illinois in respect to the different climatic faunal zones which radiate from it in all directions.

SURPRISING VARIETY OF HABITATS IN STATE

Illinois is usually thought at first glance to be a relatively unproductive collecting ground. Most of the traveled part of the state is flat or only slightly hilly, and under intensive cultivation. The scattered woodlots are usually bare of undergrowth and grazed to their full extent. This impression of the uninteresting nature of the state is erroneous, as a journey through the less populous areas and some of the out of the way places shows.

The state is primarily an alternation of prairie and oak-hickory or mixed forest. The northern two-thirds is mostly prairie, with forest along the north and west borders, and the southern third is almost entirely forest. The most imposing hills lack sufficient elevation to afford the faunal zonation which is occasioned by changes in altitude. The extremely diverse habitats to be found in Illinois are due instead to projections of various faunal regions within its borders, or to the effects of glaciation. Thus the cypress swamps of the south extend up into the southern tip of the state with their accompanying southern fauna, in the central and northern parts are several sand areas as the result of deposits by glacial rivers, and in the northeast corner of the state are many lakes and tamarack bogs which constitute the southernmost extension of the lake country of Wisconsin and northward.

Prairie.—The Illinois prairies were originally of the tall grass type, fig. 1, dominated by prairie grasses (*Andropogon furcatus* and *Scoparius*, *Sorghastrum*, *Sporobolus* and others), and by large herbs such as rosinweed (*Silphium terebinthenaceum*). This type of habitat has been reduced more than the forest by cultivation, and throughout the central portion of the state is best represented along the railroad right of ways. This disturbing of the natural sod has doubtless had a detrimental effect upon the general distribution of some of the prairie grasshoppers, but many of them have

taken quite readily to pastures, abandoned grassland, roadsides and the like. The more abundant prairie grasshoppers include *Syrbula admirabilis*, *Hippiscus rugosus*, *Encoptolophus sordidus* and *Arphia sulphurea*. The latter is frequently the dominant grasshopper in dry, well grazed pastures. The conehead *Neoconocephalus ensiger* occurs locally on long grass prairie. The meadow katydids seem to show a preference for moist and weedy situations.

Sand areas.—More than any other factor, the pure sand areas of Illinois are responsible for the occurrence within the state of many interesting



Fig. 3.—Portion of cattail swamp. The cattails are the habitat of *Truxalis brevicornis*. The grasses around the habitats contain species of *Conocephalus* and *Orchelimum*, in addition to some of the rarer grasshoppers.

species of grasshoppers. There are several large sand deposits in Illinois. Those along the Mississippi river at Hanover, Savanna and Oquawka, and at Havana, fig. 2, Beach and Dixon, contain considerable bare sand with many blow-outs and dunes. Those at Amboy, Kankakee and especially Winnebago are covered mostly with black oak woods. Those with the greatest amount of free sand display the more interesting fauna.

Bare sand is seemingly the sole habitat of *Trimerotropis maritima interior*, which is practically the only Illinois species so restricted. The commoner grasshoppers of the sparsely covered sand ridges are *Melanoplus angustipennis* and *M. flavidus*, *Ageneotettix deorum*, *Spharagemon collare* and *Psinidia fenestralis*. The ridges with taller and thicker cover usually have an abundant population of *Schistocerca alutacea* in addition to some of the others mentioned, and frequently some of the grassland species, such as *Syrbula admirabilis*.

The Havana sand area along the Illinois river is the most extensive in the state. It has large tracts of bare or sparsely covered sand, intermingled with forested dunes and blow-outs. In addition to the grasshopper fauna

characteristic of all the sand areas of the state, several western species have been found there and nowhere else in Illinois, for instance *Amphitornus coloradus* and *Mermiria neomexicana*.

The Beach area is equally noteworthy. It extends north along the margin of Lake Michigan from Waukegan, continuing beyond the Wisconsin line, and consists of a series of low sand ridges paralleling the lake front and backed by sand prairie. The ridges along the beach are almost bare, whereas those further from the beach have progressively heavier and denser cover. Between the sand ridges are numerous semimarshy swales, and through the prairie run several marsh areas. This multitude of different conditions has an equally varied Orthopteran fauna which includes several northern species taken only at this point in the state.

Swampy areas.—From the standpoint of Orthoptera, the significance of most of the swamps, bogs and marshes of Illinois lies in the wet areas of sedges, grass and weeds which form their borders, fig. 3. In these moist situations are found large numbers of meadow katydids, sometimes five or six species in the same location. Only in a few instances have true reed or cattail inhabiting species been taken in the state, notably *Truxalis brevicornis*. Frequently ground crickets, grouse locusts and some short winged Acrididae are found in the same places. The mud flats along ponds, rivers and streams are the favorite habitat of many of the grouse locusts and of the pygmy mole crickets *Tridactylus apicalis* and *T. minutus*.

Shrubby places.—The dense growth of rank herbs and shrubs along ditches, fence rows, forest edges, etc., harbors large numbers of Orthoptera. In the shrubbery itself occur the katydid *Amblycorypha oblongifolia*, various species of meadow katydids of the genera *Orchelimum* and *Conocephalus*, and such grasshoppers as *Melanoplus differentialis* and *M. femur-rubrum*. On the ground are found numerous ground crickets and short winged grasshoppers, e.g., *Dichromorpha viridis* and *Melanoplus scudderi*. Frequently large numbers of tree crickets (*Oecanthus spp.*) may be found in such shrubbery and in nearby patches of tall herbs.

Forest.—The Illinois forests are entirely deciduous except for very small and isolated tracts of pine, or scattered trees of red cedar and arbor vitae. The river bottom forests are characterized by elm, soft maple, cottonwood and sycamore; the upland forests by hard maple and various species of oak and hickory, with some beech in a few localities in the extreme eastern and southern portions of the state. The upland forests have moderately dense to sparse undergrowth, and are in places interrupted by small glades, fig. 4.

In the northern part of the state the forest floor and undergrowth are the favorite habitats for a considerable number of species, such as the short

winged *Melanoplus viridipes*, *M. fasciatus*, *Chloealtis conspersa* and various ground crickets, including *Atlanticus testaceus* and species of *Nemobius*. In the foliage of the trees and larger shrubs may be found the true katydid, *Pterophylla camellifolia*. In the southern part of the state the forest floor *Melanopli* are represented chiefly by *Melanoplus walshii* and *M. obovati-pennis*; and the forest tree cricket *Oecanthus latipennis* and brown wood

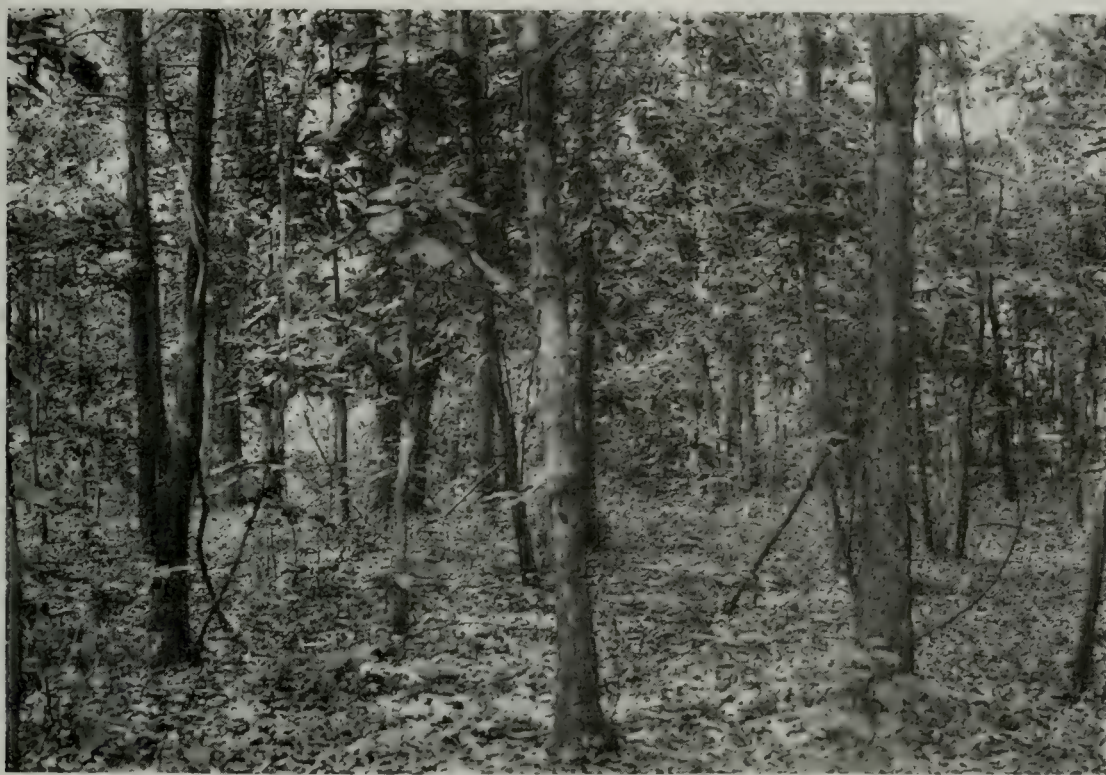


Fig. 4.—Oak-hickory woods at Charleston, Ill. Habitat of *Melanoplus viridipes*, *Melanoplus fasciatus*, *Atlanticus testaceus* and other species. (After Adams, Bul. Ill. State Lab. Nat. Hist., vol. XI, art. II.)

cricket *Hapithus agitator* become abundant, especially in the thick shrubbery in the glades.

The Ozark hills in southern Illinois form a broad band of rolling and semiprecipitous hills extending east and west across the state. They are densely forested with oak and hickory, and profusely cut up by small streams into gullies and valleys. Practically every forest situation is represented in a comparatively small area, from dense floodplain forest to the thinner types of woods, among which treeless vegetation occurs locally on rock ledges and bluffs, fig. 5. Interspersed with the forest are small patches of prairie, pasture and cultivated land. This assemblage of conditions contains a rich Orthopteran fauna, including not only the species found almost generally over the state, but in addition a considerable number of species of decided southern distribution and not found in Illinois north of the Ozarks. A notable example is *Trimerotropis saxatilis*, taken on sandstone

ledges partially covered with lichens; others are *Ischnoptera deropeltiformis*, *Parcoblatta fulvescens*, *Anisomorpha ferruginea*, *Atlanticus americanus* and *Cyrtoxipha columbiana*.

Cypress bottoms.—The southern tip of the state harbors a northern extension of the cypress, which together with tupelo gum and buttonbush forms the swamps of the backwaters and river bottoms. At one time these



Fig. 5.—Wooded rock formation near Anvil Rock in the Ozark hills in southern Illinois. The lichen covered rocks are the habitat of *Trimerotropis saxatilis*. (Photo by Turner.)

cypress swamps were very plentiful in Illinois south of the Ozarks, but due to cutting off for lumber and drainage for cultivation only scattered remnants of them remain in the Mississippi, Cache and Wabash river bottomlands. A few Orthoptera have been taken in Illinois only in this southern floodplain region, *e.g.*, *Neotettix bolteri*, *Schistocerca obscura*, *Neoconocephalus triops*, *Montezumina modesta* and others. There is found here also the interesting species *Inscudderia taxodii* which has so far been captured exclusively on cypress.

SUMMARY OF LITERATURE

THOMAS

THE PUBLISHED DATA on the Orthoptera of Illinois have not been elaborate, but for the times decidedly more satisfactory than for most of the middle western states. In 1876 Cyrus Thomas published "A List of the Orthoptera of Illinois,"³ including a single species of Dermaptera but

³See bibliography, p. 259.

omitting the Tettigoniidae and Gryllidae. Forty-six species were discussed and only in two cases was the same species recorded under two names, but since that time much nomenclatorial change has occurred. In 1880 Thomas published "The Acrididae of Illinois." Thirty-six species were included though the Acrydiinae were omitted, the same errors occurring which appeared in his earlier report.

MCNEILL

In 1891 Jerome McNeill's "List of the Orthoptera of Illinois" was published. One hundred and ten species were reported, but in 13 cases the same species was recorded under two names and three species which do not occur in Illinois were included.

HART AND VESTAL

In 1907 in a study of the sand areas of Illinois, Charles A. Hart reported the Orthoptera found there, 67 species. In only two cases was the same species recorded under two names, but unfortunately the single species then described is a synonym. A number of important new records for the state were included. Continuing that study, in 1913 Arthur Gibson Vestal listed 34 species in his report called "An Associational Study of Illinois Sand Prairie."

BLATCHLEY

Many important records for Illinois are also scattered through the literature, particularly in revisionary studies and W. S. Blatchley's "Orthoptera of Northeastern America" which appeared in 1920.

COLLECTION AND DISPOSITION OF THE MATERIAL

THE EXTENSIVE COLLECTIONS made by Hart, Theodore H. Frison, H. H. Ross, C. O. Mohr and others of the ILLINOIS STATE NATURAL HISTORY SURVEY, or its predecessors the Illinois State Laboratory of Natural History and Office of State Entomologist, together with the Hancock collection belonging to the author, have afforded the basis for the present study. To these has been added all the Illinois material which has come into our hands or has been examined by us, the most important being the small but exceptionally valuable series belonging to the Field Museum, largely collected by W. J. Gerhard.

We here record more than 10,000 specimens from Illinois, representing 173 species and nine additional races or varieties, two of these being new to science. Ten more species and one race whose range should include part of Illinois will bring the total to 193 species and races for the state. This does not include one adventive earwig and seven adventive cockroaches found in the state. Though the great majority of the species

of Illinois are characteristic of the upper and lower austral zones of the eastern United States, eight boreal species and eight which find their widest distribution and greatest abundance on the great plains occur here.

Collecting in Illinois in the order has been so generally accomplished that we believe very few additional species will be found. It is however obvious that there will be some, and we have discussed briefly those species which have not yet been secured but which we expect to occur. These are *Periplaneta australiasiae* (Fabricius), *Diapheromera velii* Walsh, *Nomotettix cristatus compressus* Morse, *Leptysma marginicollis* (Serville), *Orchelimum bullatum* Rehn and Hebard, *Atlanticus davisii* Rehn and Hebard, *Hadenoeus puteanus* Scudder, *Phrixocnemus truculentus* Scudder, *Ceuthophilus seclusus* Scudder, *C. meridionalis* Scudder and *C. brevipes* Scudder.

LOCALITIES

The map, fig. 6, shows the localities in Illinois from which material has been secured. Descriptions in the catalog of species which follows, pp. 150-259, give the localities in numerical order, beginning in the northeast corner of the state and ending at a southwestern limit. The alphabetized list on pp. 138-139 keys each locality.

PRESENT HOLDERS OF MATERIAL: SYMBOLS

If not otherwise noted the material listed in this paper belongs to the ILLINOIS STATE NATURAL HISTORY SURVEY. Material in the collections of other institutions or individuals is so designated by the use of the following symbols.

ANS.—Academy of Natural Sciences of Philadelphia

BC.—Brues Collection

FM.—Field Museum

HC.—Hebard Collection

ISC.—Iowa State College

MCZ.—Museum of Comparative Zoology

MMZ.—University of Michigan Museum of Zoology

NM.—United States National Museum

OSU.—Ohio State University

PU.—Purdue University

TC.—Thomas Collection

UM.—University of Minnesota

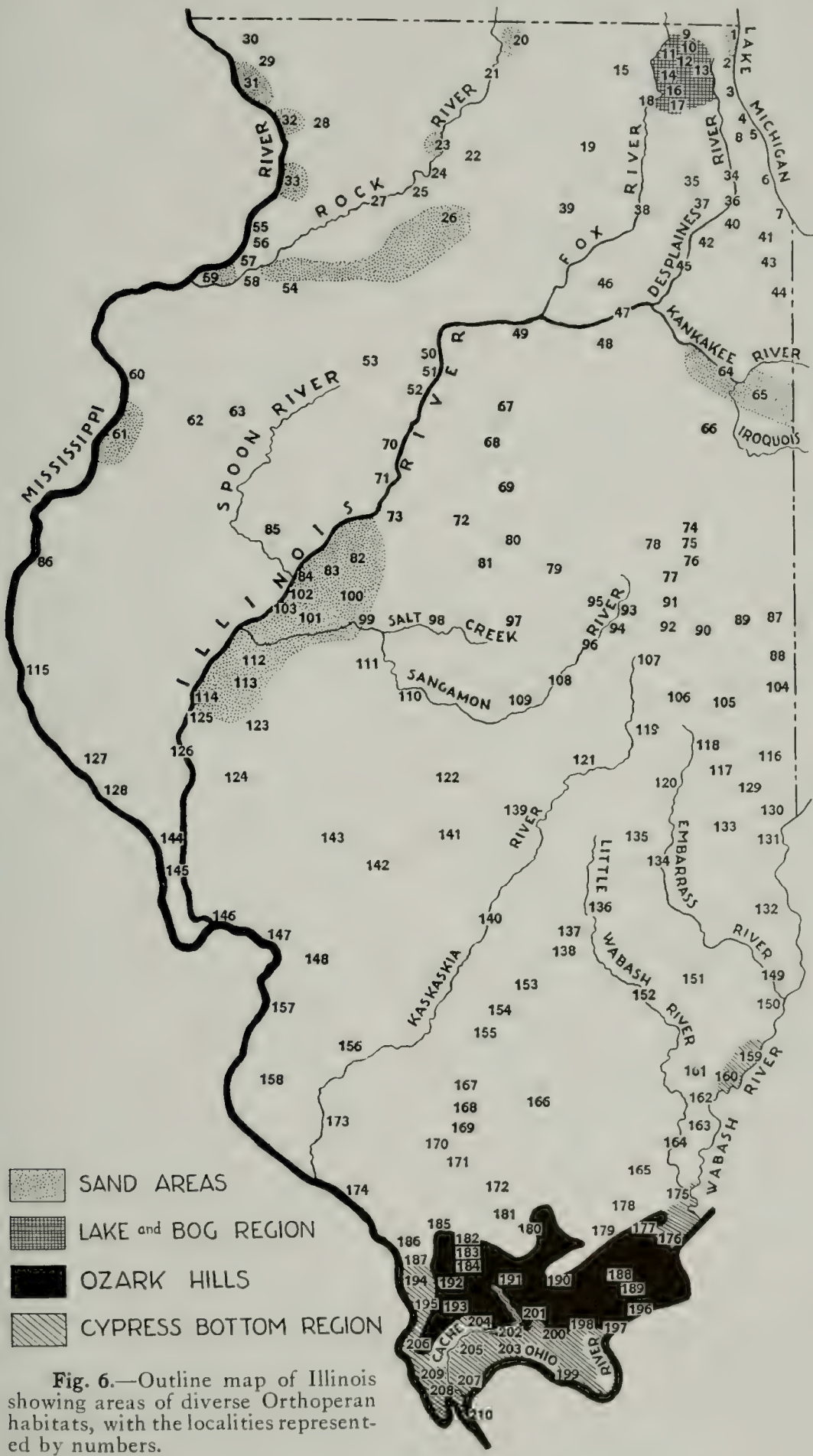


Fig. 6.—Outline map of Illinois showing areas of diverse Orthoperan habitats, with the localities represented by numbers.

Albion.....	161	Champaign.....	92	Fountain Bluff.....	186
Aldridge.....	194	Champaign county...	92	Fourth Lake.....	10
Algonquin.....	18	Chana.....	22	Fox Lake.....	11
Alma.....	153	Channel Lake.....	9	Fulton.....	33
Alton.....	147	Charleston.....	120	Funks Grove.....	81
Alto Pass.....	192	Chautauqua.....	146	Galena.....	30
Amboy.....	26	Chester.....	174	Galesburg.....	63
Anna.....	193	Chicago.....	6	Galton.....	119
Antioch.....	9	Clarksville.....	129	Geneseo.....	54
Anvil Rock Hills.....	188	Clay City.....	152	Georgetown.....	88
Arcola.....	119	Cleveland.....	59	Glencoe.....	4
Arenzville.....	113	Clinton.....	97	Glen Ellyn.....	35
Argo.....	36	Cobden.....	192	Glenview.....	8
Ashkum.....	66	Colona.....	58	Golconda.....	197
Ashley.....	167	Conover.....	101	Goreville.....	191
Athens.....	111	Cook county.....	7	Grafton.....	146
Augerville.....	92	Cordova.....	55	Grand Detour.....	24
Aurora.....	38	Crete.....	44	Grand Tower.....	187
Baldwin.....	173	Crossville.....	163	Grays Lake.....	13
Barrington.....	17	Cuba.....	85	Grayville.....	162
Bartonville.....	71	Cypress.....	202	Green River.....	58
Bath.....	103	Cypress Creek.....	202	Hamilton.....	86
Beach.....	1	Danvers.....	72	Hanover sand area...	31
Benson.....	68	Danville.....	87	Hardin.....	145
Beverly Hills.....	41	Decatur.....	109	Harrisburg.....	179
Billett.....	150	Deep Lake.....	10	Havana.....	84
Bishop.....	83	Devil's Hole.....	84	Henry.....	51
Bloomington.....	80	Devil's Neck.....	84	Henry county.....	54
Bluffs.....	125	Dixon.....	25	Herod.....	188
Bluff Springs.....	112	Dixon Springs.....	198	Herrin.....	181
Borton.....	118	Dongola.....	204	Hicks Branch.....	188
Boskydell.....	183	Downers Grove.....	37	Hilliary.....	87
Bowmanville.....	6	Dubois.....	168	Hillsboro.....	142
Bradford.....	53	Du Quoin.....	171	Homer.....	90
Browns.....	161	East Cape Girardeau...	206	Hume.....	105
Bryant.....	85	East St. Louis.....	157	Jacksonville.....	123
Cache.....	208	Edgewater.....	7	Jewett.....	134
Cairo.....	210	Edgewood.....	137	Joliet.....	45
Camargo.....	106	Edwardsville.....	148	Jonesboro.....	193
Carbondale.....	182	Eichorn.....	189	Kampsville.....	144
Carlinville.....	143	Eldorado.....	178	Kankakee.....	64
Carmi.....	164	Elizabeth.....	29	Kansas.....	117
Carterville.....	181	Elizabethtown.....	196	Kappa.....	69
Cary.....	13	Elliott.....	78	Karnak.....	202
Casey.....	133	Equality.....	177	Keensburg.....	160
Cedar Lake.....	10	Evanston.....	5	Keithsburg.....	60
Centerville.....	94	Farina.....	138	Kenilworth.....	4
Central.....	46	Fithian.....	89	La Grange.....	36
Central City.....	155	Florence.....	126	Lake county.....	13
Centralia.....	155	Flossmoor.....	43	Lake Forest.....	3
Cerro Gordo.....	108	Forest City.....	92		

Lake Senachwine.....	50	Olive Branch.....	208	Sterling.....	27
Lake Villa.....	10	Olney.....	150	Sullivan.....	121
Lawrenceville.....	149	Oquawka sand area...	61	Summit.....	36
Lemont.....	42	Oregon.....	23	Sun Lake.....	10
Le Roy.....	79	Ottawa.....	49	Sycamore.....	19
Leslie.....	73	Palos Park.....	42	Tamaroa.....	169
Lincoln.....	98	Paris.....	116	Taylorville.....	122
Litchfield.....	142	Parker.....	190	Teheran.....	100
Loda.....	74	Paxton.....	75	Thebes.....	209
Long Lake.....	12	Pekin.....	73	Thomasboro.....	91
Ludlow.....	76	Peoria.....	71	Tolono.....	107
McClure.....	206	Perry county.....	170	Tonti.....	154
McCulloms Lake.....	14	Pike.....	128	Topeka.....	83
Mackinaw Station....	72	Pinckneyville.....	170	Tower Hill.....	139
Mahomet.....	93	Pine Hills.....	187	Tremont.....	73
Makanda.....	184	Pistakee Bay.....	11	Twin Grove.....	80
Manchester.....	124	Port Byron.....	56	Ullin.....	205
Manito.....	82	Prairie View.....	17	Union county.....	193
Mansfield.....	95	Prospect.....	77	Urbana.....	92
Marion.....	180	Prospect Hill.....	188	Vandalia.....	140
Marshall.....	130	Pulaski.....	205	Vermilion county....	89
Martinsville.....	133	Pullman.....	7	Verona.....	48
Mascoutah.....	156	Putnam.....	50	Vienna.....	201
Mason City.....	99	Quincy.....	115	Villa Ridge.....	207
Matanzas Lake.....	102	Quiver Lake.....	84	Volo.....	14
Mayview.....	92	Rantoul.....	77	Volo Lake.....	14
Maywood.....	34	Ravinia.....	4	Wamble Mountain...	188
Meredosia.....	114	Riverdale.....	41	Ware.....	195
Metropolis.....	199	Riverside.....	36	Waterloo.....	158
Milan.....	59	Riverview.....	8	Waterman.....	39
Moline.....	59	Robinson.....	132	Watertown.....	57
Monmouth.....	62	Rockford.....	21	Watson.....	136
Monticello.....	96	Rock Island.....	59	Wauconda.....	16
Mossville.....	70	Rock Island county...	59	Waukegan.....	2
Mt. Carmel.....	159	Rockport.....	127	West Havana.....	84
Mt. Carroll.....	28	Running Lake.....	182	West Union.....	131
Mt. Vernon.....	166	Rutland.....	67	White Heath.....	94
Muncie.....	89	St. Anne.....	65	Whitehill.....	203
Murphysboro.....	185	St. Francisville.....	150	Williams Mountain...	188
Neoga.....	135	St. Joseph.....	90	Willow Springs.....	40
New Columbia.....	200	Saratoga I.....	47	Wilmette.....	5
New Haven.....	175	Saratoga II.....	192	Winnebago county	
Newman.....	105	Savanna.....	32	sand area.....	20
Nokomis.....	141	Seymour.....	94	Winnetka.....	4
Normal.....	80	Shawneetown.....	176	Wolf Lake.....	195
Norris City.....	165	Snyder.....	131	Woodstock.....	15
Oakland.....	118	Sparland.....	52	Woodyard....	104
Oaklawn.....	40	Spaulding.....	110	Zeigler.....	172
Oakwood.....	89	Starved Rock State		Zion.....	1
Odin.....	154	Park.....	49		
Ogden.....	90				

USE OF THE KEYS

THE KEYS IN THIS PAPER are intended solely as an aid to the student in determining the species of Orthoptera and Dermaptera found in Illinois. No attempt is made to assist in distinguishing other related species not known from the state. This must be kept in mind especially in a few cases of generic diagnosis where for the sake of clarity an aggregate of artificial characters has been used, as with *Melanoplus* and *Orchelimum* and their nearest relatives. A great many characters have been illustrated to elucidate couplets in the keys, and it is recommended that students consult the following plates I-IV, figs. 7-141, freely when identifying specimens. Only characters of maximum diagnostic value are given. As most species are subject to some individual variation any difficult specimen should not be determined from the key alone, but efforts should be made to locate it more safely by recourse to the latest revision of the group to which it belongs. If that cannot be done the specimen should be submitted to a specialist.

GLOSSARY

A number of terms in the keys may not be familiar to the general entomology student. Those which appear most commonly in this paper are defined as follows.

- aciculate.**—extremely sharp and needle-like.
admesal.—alongside the meson.
anal field.—posterior portion of tegmen, or front wing, fig. 32, A, dorsal in repose.
annulus.—a circular, transverse band.
arboreal.—living in trees.
arcuate.—curved like a bow, *i.e.*, in an arc.
arolium.—a cushion-like pad on the ventral surface or “sole” of the foot.
asperate.—rough with elevated dots.
auricula.—earlike lobe or appendage.
bisinate.—having two curved incisions or emarginations.
brachypterous.—having short wings, fig. 150, p. 151.
calcar.—one of the large spurs at apex of the caudal tibia.
campestran.—inhabiting open fields.
carina.—a keel, fig. 17.
caudate.—with taillike extensions or processes.
cerci.—the flaplike appendages on each side of the male genitalia, fig. 66, c.
clavate.—club shaped, fig. 25.
clypeus.—a sclerite above the upper lip.
cristate.—having a crest, fig. 17.
cristation.—a crest.
coriaceous.—thick, tough and leathery.
deplanate.—flattened or level.
discoidal vein.—the vein from which the median vein arises, situated in the median field.
disk of pronotum.—the entire dorsal aspect of pronotum or “saddle,” fig. 36.
divaricate.—spreading apart.
ensiform.—pennant shaped, fig. 26.
explanate.—spread out and flattened.
falcate.—sickle shaped.
fastigium.—the anterior portion of dorsum, or top of head, fig. 22.
fenestrate.—with a lattice-like pattern.
foramen.—an opening into the body or into an appendage.
foveolae.—small pits.
frontal costa.—the ridge or raised, flat area extending down the meson, or middle line, of the face, fig. 27, fc.
furcate.—forked.
furcula.—a paired or forked appendage at the base of the dorsal portion of the male genitalia, fig. 66, fr.

- fusiform.**—spindle shaped.
- genicular areas of femora.**—apical portion of femora forming part of the "knee" joint.
- hirsute.**—hairy.
- humeral sinus.**—the incision frequently present in the dorsoposterior margin of the lateral lobes of the pronotum, fig. 113, h.
- hyaline.**—transparent.
- hygrophilous.**—inhabiting moist or wet places.
- infumate.**—smoky.
- infusate.**—darkened.
- lamellate.**—having a thin, raised plate or leaflike process.
- lamina.**—a thin plate.
- lateral foveolae.**—pits or grooves in the lateral margin of the fastigium, fig. 54, lf.
- macula.**—a marking; a spot.
- marginal field.**—anterior portion of tegmina, fig. 32, M, ventral in repose.
- median carina of head.**—the carina along meson of dorsal portion of head, fig. 21, mc.
- median or discoidal field.**—middle portion of tegmina, fig. 32, D.
- median vein.**—a vein of the median field, fig. 97, mv.
- mediastine vein.**—the subcostal vein behind the costal margin, in the marginal field.
- mesonotum.**—the dorsal region of the mesothorax, situated directly behind the "saddle."
- mesosternum.**—the ventral plate of the mesothorax, between and in front of the bases of the middle pair of legs.
- metazona.**—the posterior portion of disk of pronotum, fig. 42, mz.
- ocelli.**—the small lenses between the eyes on the front of the head.
- pagina.**—the outer flattened surface of the caudal or hind femora.
- palpi.**—the feeler-like appendages of the mouthparts, fig. 41, pp.
- paraprocts.**—sclerites on the apical region of the abdomen.
- piceous.**—a brownish or reddish shade of black.
- plantula.**—the pad on the ventral surface of the basal segment of the "foot."
- poculum.**—the ventral sacklike appendage of the male genitalia in the Phasmidae.
- pregenicular.**—before the "knee" area.
- prosternum.**—the ventral plate of the prothorax, between the bases of the anterior pair of legs.
- proximal.**—the part of an appendage nearest the body.
- prozona.**—the anterior portion of disk of pronotum, fig. 42, pz.
- pulvillus.**—the pad between the claws at the end of the foot.
- rugae.**—raised, threadlike portions of the surface, or small wrinkles.
- scalariform.**—ladder-like.
- setose.**—set with fine hair.
- sinuate.**—curved.
- spatulate.**—flattened club shaped, the apex rounded, fig. 79.
- speculum.**—the glassy area at the base of the tegmina of some males.
- style.**—a finger-like process, fig. 95.
- subgenital plate.**—the last apparent ventral segment, or sternite, fig. 66, s.
- submacropterous.**—having wings which are not quite full length.
- subplanate.**—nearly flat.
- subpyriform.**—nearly pear shaped.
- sulcate.**—grooved.
- sulci.**—grooves or channels.
- supracoxal.**—situated above the coxa.
- taenia.**—a broad, longitudinal stripe.
- tectate.**—roof shaped, fig. 17.
- tectation.**—a roof shaped area.
- teneral.**—recently molted specimens not having attained their full color or hardness.
- tergite.**—the dorsal part of a segment.
- tesellate.**—checkered.
- testaceous.**—dull yellowish brown.
- trifasciate.**—having three bands.
- triquetrous.**—with three flat sides.
- ulnar vein.**—a vein of the median field, fig. 97, uv.
- unicarinate.**—having one ridge or carina.
- velutinous.**—velvety.
- vertex.**—top of head.
- vittate.**—striped.

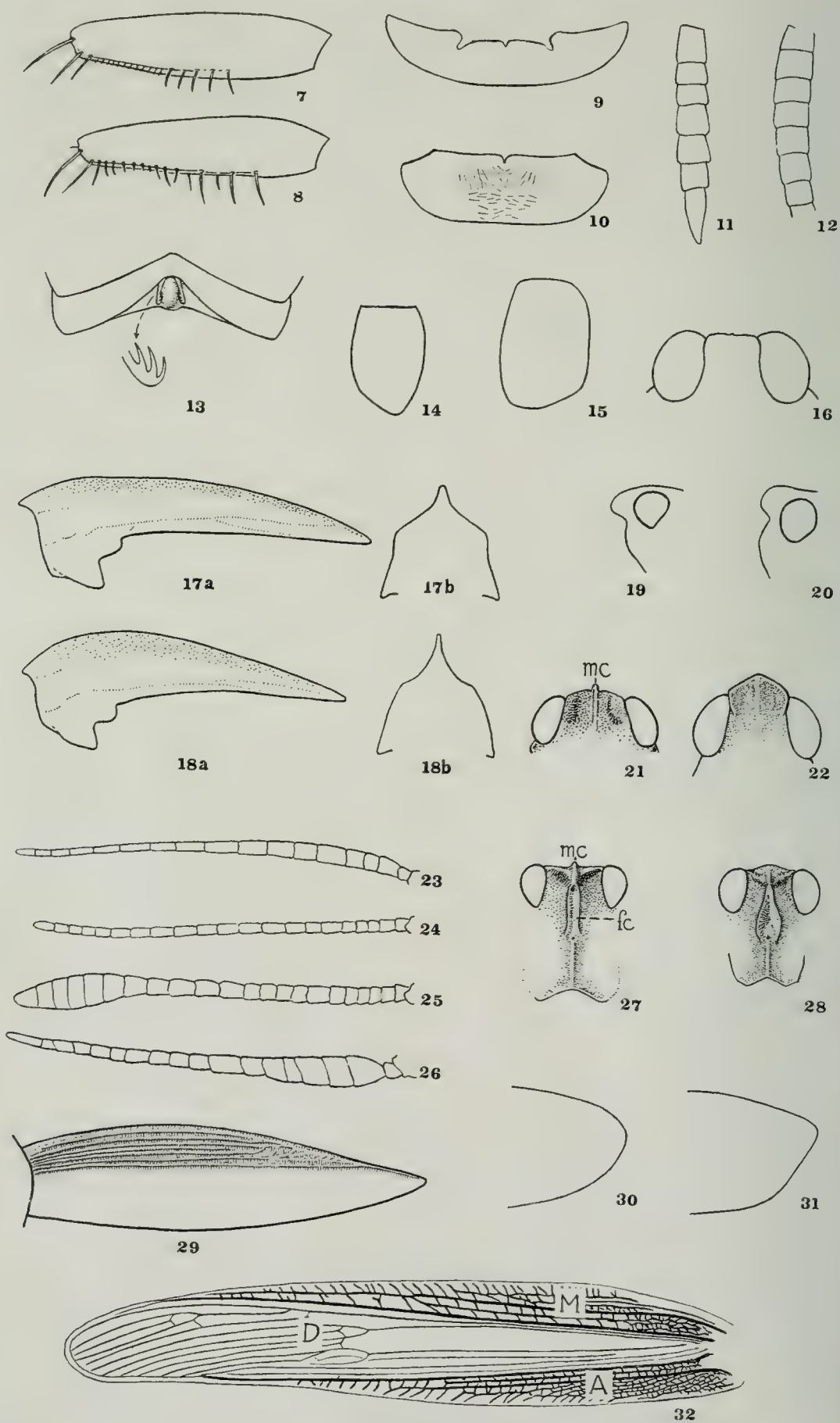


PLATE I

PLATE I

- Fig. 7.—Anterior femur of *Parcoblatta pennsylvanica* (DeGeer), anterior aspect.
 Fig. 8.—Anterior femur of *Blattella germanica* (Linnaeus), anterior aspect.
 Fig. 9.—First abdominal (median) tergite of *Parcoblatta bolliana* (Saussure and Zehntner), male.
 Fig. 10.—First abdominal tergite of *Parcoblatta virginica* (Brunner), male.
 Fig. 11.—Portion of cercus of *Parcoblatta uhleriana* (Saussure).
 Fig. 12.—Portion of cercus of *Parcoblatta fulvescens* (Saussure and Zehntner).
 Fig. 13.—Sixth abdominal tergite of male *Ischnoptera deropeltiformis* (Brunner).
 Fig. 14.—Tegmen of female *Parcoblatta lata* (Brunner).
 Fig. 15.—Tegmen of female *Parcoblatta fulvescens* (Saussure and Zehntner).
 Fig. 16.—Anterior portion of head of female *Paratettix cucullatus* (Burmeister), dorsal aspect.
 Fig. 17.—Pronotum of *Nomotettix cristatus cristatus* Scudder; a, lateral aspect, b, anterior aspect.
 Fig. 18.—Pronotum of *Nomotettix cristatus denticulatus* Morse; a, lateral aspect, b, anterior aspect.
 Fig. 19.—Fastigium of *Nomotettix parvus* Morse, lateral aspect.
 Fig. 20.—Fastigium of *Nomotettix cristatus cristatus* Scudder, lateral aspect.
 Fig. 21.—Fastigium of *Acridium ornatum* (Say), dorsal aspect.
 Fig. 22.—Fastigium of *Acridium granulatum* Kirby, dorsal aspect.
 Fig. 23.—Antenna of female *Psinidia fenestralis fenestralis* (Serville).
 Fig. 24.—Antenna of female *Orphulella pelidna* (Burmeister).
 Fig. 25.—Antenna of male *Eritettix simplex* (Scudder).
 Fig. 26.—Antenna of female *Truxalis brevicornis* (Linnaeus).
 Fig. 27.—Portion of head of *Acridium ornatum* (Say), anterior aspect.
 Fig. 28.—Portion of head of *Neotettix bolteri* Hancock, anterior aspect.
 Fig. 29.—Right tegmen of female *Pseudopomala brachyptera* (Scudder).
 Fig. 30.—Tip of tegmen of *Truxalis brevicornis* (Linnaeus).
 Fig. 31.—Tip of tegmen of *Mermiria maculipennis macclungi* Rehn.
 Fig. 32.—Left tegmen of *Melanoplus mexicanus mexicanus* (Saussure).

ABBREVIATIONS

- A—anal field
 D—median or discoidal field
 M—marginal field
 fc—frontal costa
 mc—median carina

PLATE II

- Fig. 33.—Fastigium of *Chloealtis conspersa* Harris, dorsal aspect.
 Fig. 34.—Fastigium of *Orphulella pelidna* (Burmeister), dorsal aspect.
 Fig. 35.—Fastigium of *Amphitornus coloradus* (Thomas), dorsal aspect.
 Fig. 36.—Head and prothorax of *Trachyrhachis kiowa fuscifrons* (Stal), lateral aspect.
 Fig. 37.—Pronotum of *Dichromorpha viridis* (Scudder), dorsal aspect.
 Fig. 38.—Pronotum of *Orphulella pelidna* (Burmeister), dorsal aspect.
 Fig. 39.—Pronotum of *Orphulella speciosa* (Scudder), dorsal aspect.
 Fig. 40.—Pronotum of *Dissosteira carolina* (Linnaeus), dorsal aspect.
 Fig. 41.—Head and prothorax of *Trimerotropis saxatilis* McNeill, lateral aspect.

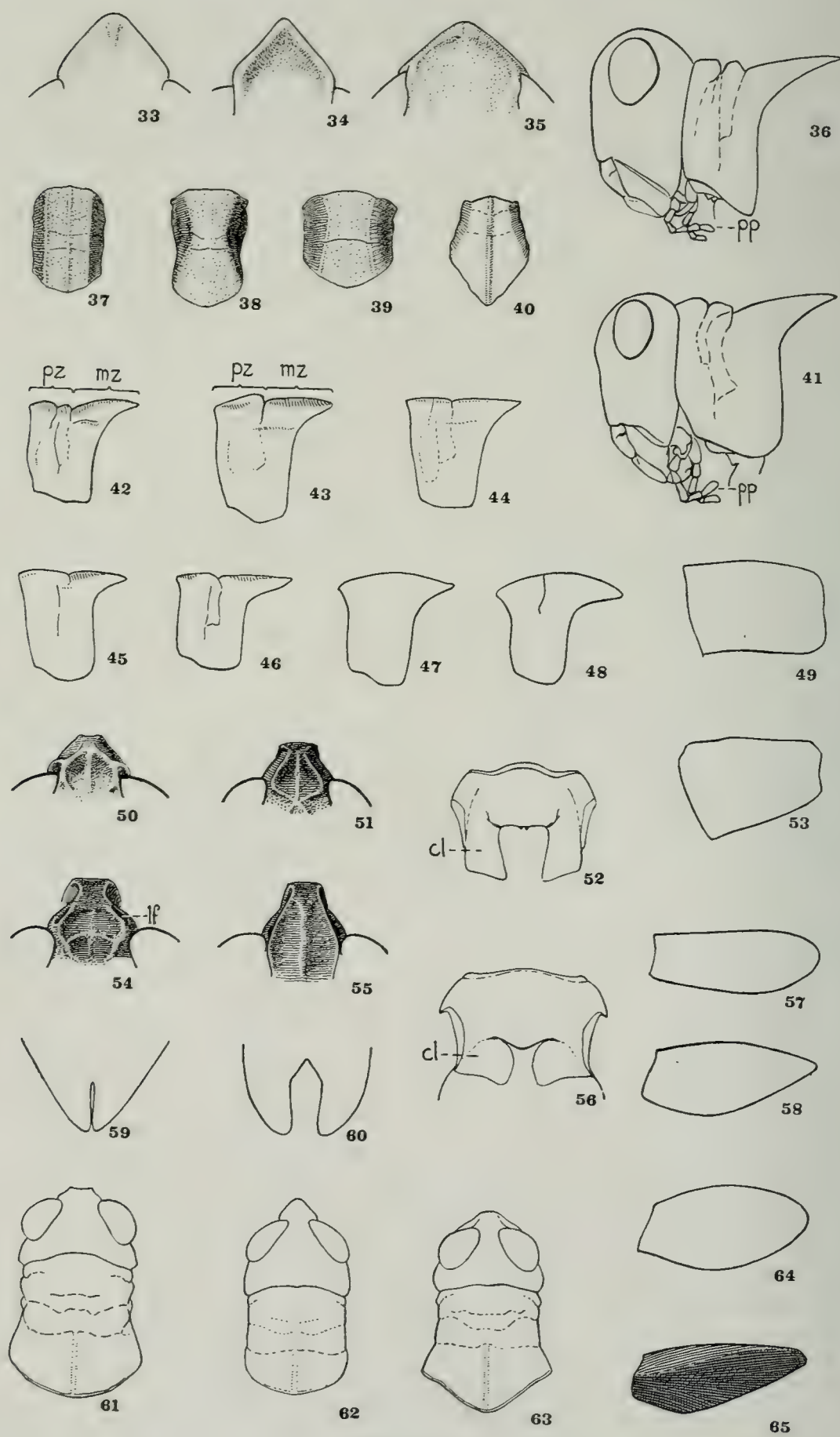


PLATE II

PLATE II—CONT'D

- Fig. 42.—Pronotum of *Psinidia fenestralis fenestralis* (Serville), lateral aspect.
 Fig. 43.—Pronotum of *Encoptolophus sordidus sordidus* (Burmeister), lateral aspect.
 Fig. 44.—Pronotum of *Camnula pellucida* Scudder, lateral aspect.
 Fig. 45.—Pronotum of *Hippiscus rugosus* (Scudder), lateral aspect.
 Fig. 46.—Pronotum of *Pardalophora phoenicoptera* (Burmeister), lateral aspect.
 Fig. 47.—Pronotum of *Arphia sulphurea* (Fabricius), lateral aspect.
 Fig. 48.—Pronotum of *Arphia zanthoptera* (Burmeister), lateral aspect.
 Fig. 49.—Cercus of *Schistocerca damnifica damnifica* (Saussure), lateral aspect.
 Fig. 50.—Fastigium of *Arphia sulphurea* (Fabricius), dorsal aspect.
 Fig. 51.—Fastigium of *Arphia pseudonietana* (Thomas), dorsal aspect.
 Fig. 52.—Mesosternum of *Schistocerca damnifica damnifica* (Saussure).
 Fig. 53.—Cercus of *Schistocerca americana americana* (Drury), lateral aspect.
 Fig. 54.—Fastigium of *Pardalophora phoenicoptera* (Burmeister), dorsal aspect.
 Fig. 55.—Fastigium of *Pardalophora apiculata* (Harris), dorsal aspect.
 Fig. 56.—Mesosternum of *Melanoplus mexicanus mexicanus* (Saussure).
 Fig. 57.—Tegmen of *Melanoplus gracilis* (Bruner).
 Fig. 58.—Tegmen of *Melanoplus dawsoni* (Scudder).
 Fig. 59.—Apex of subgenital plate of *Schistocerca damnifica damnifica* (Saussure).
 Fig. 60.—Apex of subgenital plate of *Schistocerca alutacea* (Harris).
 Fig. 61.—Head and pronotum of *Dendrotettix quercus* Packard, dorsal aspect.
 Fig. 62.—Head and pronotum of *Phoetaliotes nebrascensis* (Thomas), dorsal aspect.
 Fig. 63.—Head and pronotum of *Melanoplus mexicanus mexicanus* (Saussure), dorsal aspect.
 Fig. 64.—Tegmen of *Melanoplus scudderi scudderi* (Uhler).
 Fig. 65.—Tegmen of *Melanoplus ponderosus viola* (Thomas).

ABBREVIATIONS

- cl—caudolateral (mesosternal) lobes
 lf—lateral foveolae
 mz—metazona
 pp—palpi
 pz—prozona

PLATE III

- Fig. 66.—Apex of abdomen of male *Melanoplus mexicanus mexicanus* (Saussure), dorsolateral aspect.
 Fig. 67.—Cercus of male *Melanoplus scudderi scudderi* (Uhler), lateral aspect.
 Fig. 68.—Cercus of male *Melanoplus viridipes viridipes* Scudder, lateral aspect.
 Fig. 69.—Cercus of male *Melanoplus femur-rubrum femur-rubrum* (DeGeer), lateral aspect.
 Fig. 70.—Cercus of male *Melanoplus borealis junius* (Dodge), lateral aspect.
 Fig. 71.—Cercus of male *Melanoplus dawsoni* (Scudder), lateral aspect.
 Fig. 72.—Cercus of male *Melanoplus gracilis* (Bruner), lateral aspect.
 Fig. 73.—Cercus of male *Melanoplus obovatipennis* Blatchley, lateral aspect.
 Fig. 74.—Cercus of male *Melanoplus flavidus flavidus* Scudder, lateral aspect.

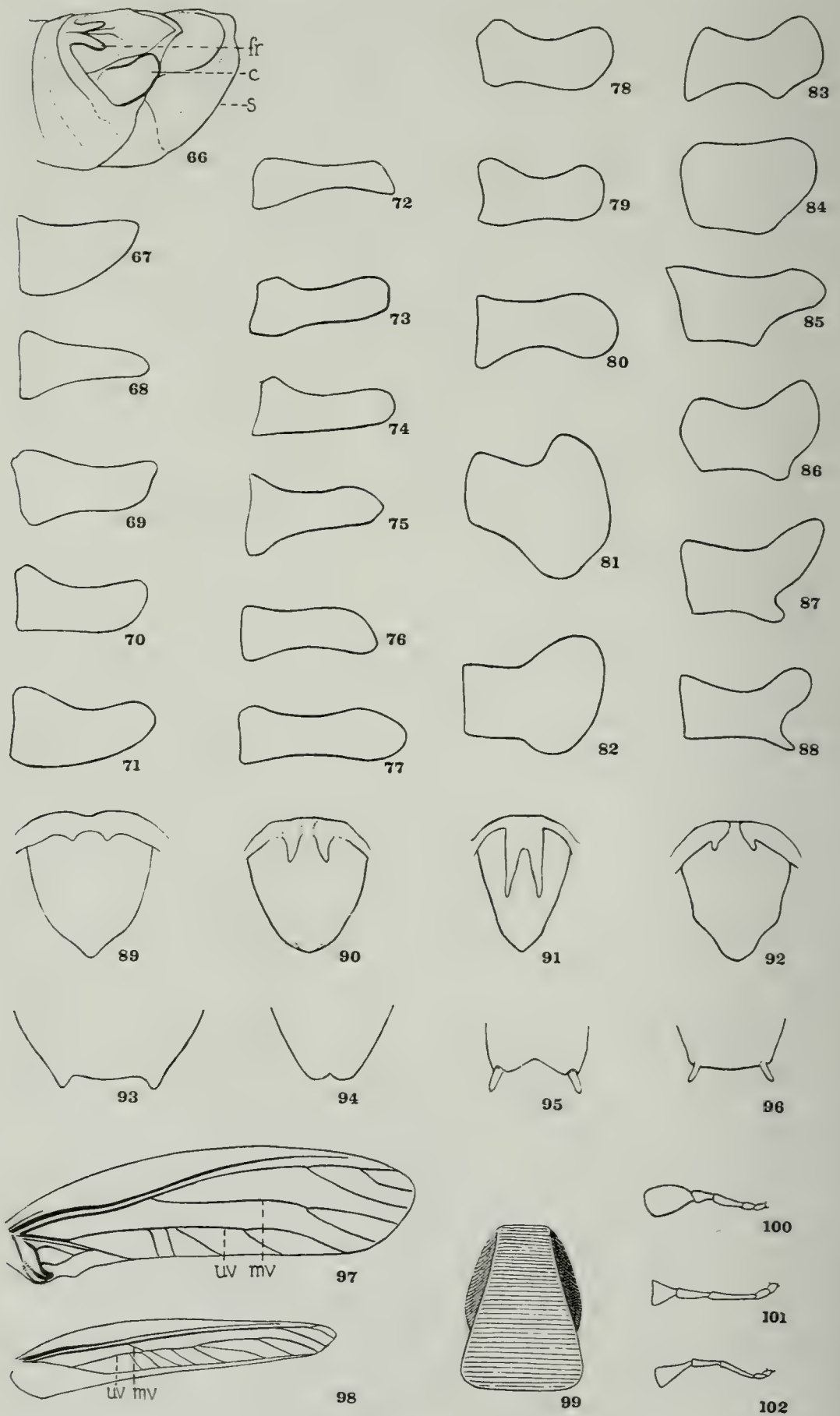


PLATE III

PLATE III—CONT'D

- Fig. 75.—Cercus of male *Melanoplus impudicus* Scudder, lateral aspect.
 Fig. 76.—Cercus of male *Melanoplus fasciatus* (F. Walker), lateral aspect.
 Fig. 77.—Cercus of male *Melanoplus fasciatus* (F. Walker), lateral aspect.
 Fig. 78.—Cercus of male *Melanoplus morsei* Blatchley, lateral aspect.
 Fig. 79.—Cercus of male *Melanoplus foedus fluviatilis* Bruner, lateral aspect.
 Fig. 80.—Cercus of male *Melanoplus angustipennis* (Dodge), lateral aspect.
 Fig. 81.—Cercus of male *Melanoplus punctulatus punctulatus* (Scudder), lateral aspect.
 Fig. 82.—Cercus of male *Melanoplus ponderosus viola* (Thomas), lateral aspect.
 Fig. 83.—Cercus of male *Melanoplus walshii* Scudder, lateral aspect.
 Fig. 84.—Cercus of male *Melanoplus mexicanus mexicanus* (Saussure), lateral aspect.
 Fig. 85.—Cercus of male *Melanoplus confusus* Scudder, lateral aspect.
 Fig. 86.—Cercus of male *Melanoplus bivittatus* (Say), lateral aspect.
 Fig. 87.—Cercus of male *Melanoplus differentialis* (Thomas), lateral aspect.
 Fig. 88.—Cercus of male *Melanoplus keeleri luridus* (Dodge), lateral aspect.
 Fig. 89.—Furcula of male *Melanoplus ponderosus viola* (Thomas).
 Fig. 90.—Furcula of male *Melanoplus walshii* Scudder.
 Fig. 91.—Furcula of male *Melanoplus borealis junius* (Dodge).
 Fig. 92.—Furcula of male *Melanoplus fasciatus* (F. Walker).
 Fig. 93.—Apex of subgenital plate of male *Melanoplus femur-rubrum femur-rubrum* (DeGeer).
 Fig. 94.—Apex of subgenital plate of male *Melanoplus mexicanus mexicanus* (Saussure).
 Fig. 95.—Apex of subgenital plate of male *Orchelimum nigripes* Scudder.
 Fig. 96.—Apex of subgenital plate of male *Conocephalus fasciatus fasciatus* (DeGeer).
 Fig. 97.—Tegmen of *Scudderia septentrionalis* (Serville).
 Fig. 98.—Tegmen of *Inscudderia taxodii* Caudell.
 Fig. 99.—Pronotum of *Atlanticus testaceus* (Scudder), dorsal aspect.
 Fig. 100.—Maxillary palpus of *Phyllopalpus pulchellus* Uhler.
 Fig. 101.—Maxillary palpus of *Cyrtoxipha gundulachi* Saussure.
 Fig. 102.—Maxillary palpus of *Anaxipha exigua* (Say).

ABBREVIATIONS

- c—cercus
 fr—furcula
 mv—median vein
 s—subgenital plate
 uv—ulnar vein

PLATE IV

- Fig. 103.—Head of *Neoconocephalus triops* (Linnaeus), lateral aspect.
 Fig. 104.—Head of *Orchelimum vulgare* Harris, lateral aspect.
 Fig. 105.—Head of *Scudderia furcata* Brunner, anterior aspect.
 Fig. 106.—Ovipositor of *Conocephalus fasciatus fasciatus* (DeGeer), lateral aspect.
 Fig. 107.—Ovipositor of *Conocephalus nemoralis* (Scudder), lateral aspect.
 Fig. 108.—Pronotum of *Orchelimum vulgare* Harris, lateral aspect.

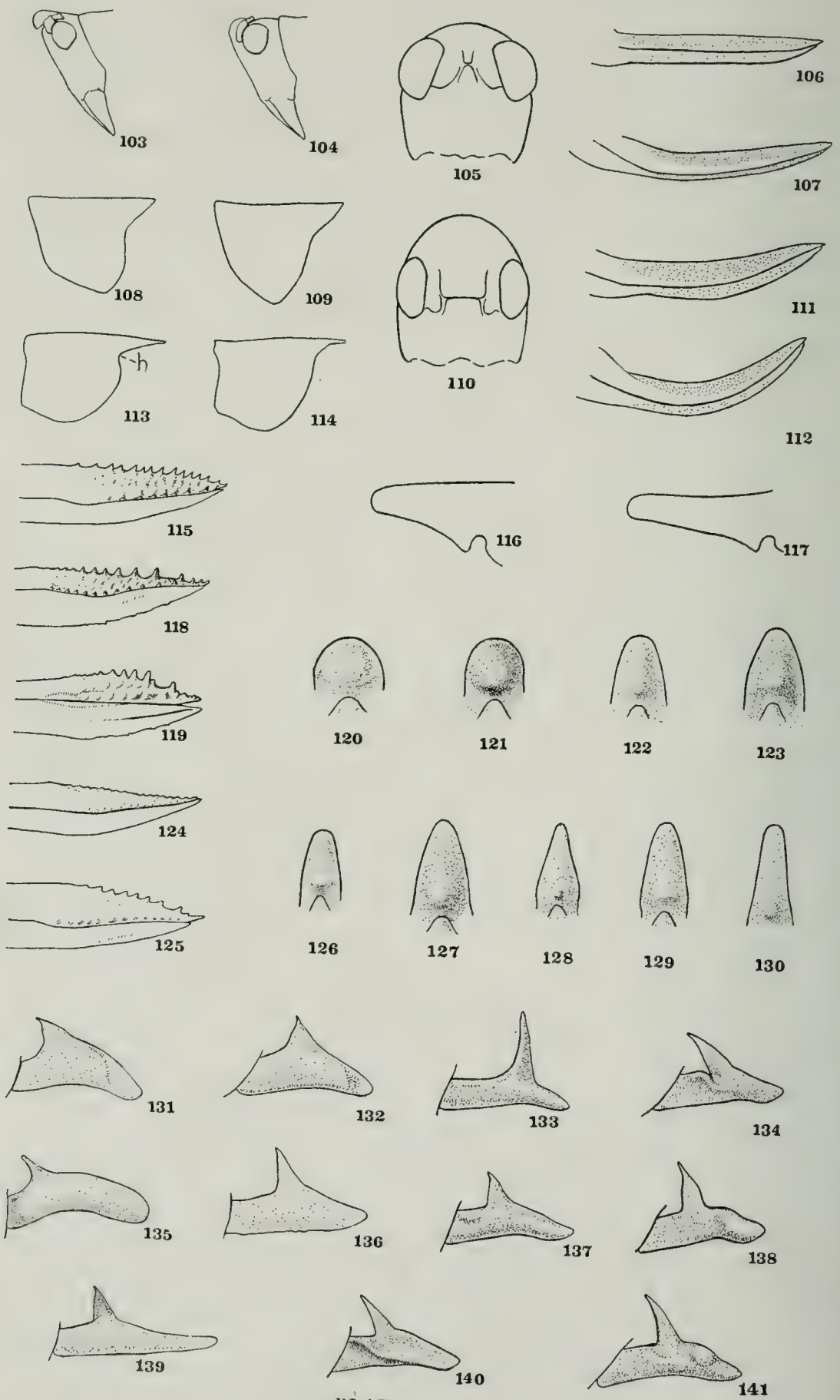


PLATE IV

PLATE IV—CONT'D

Fig. 109.—Pronotum of *Orchelimum gladiator* (Bruner), lateral aspect.

Fig. 110.—Head of *Amblycorypha oblongifolia* (DeGeer), anterior aspect.

Fig. 111.—Ovipositor of *Orchelimum volantum* McNeill, lateral aspect.

Fig. 112.—Ovipositor of *Orchelimum concinnum concinnum* Scudder, lateral aspect.

Fig. 113.—Pronotum of *Amblycorypha uhleri* Stal, lateral aspect.

Fig. 114.—Pronotum of *Amblycorypha rotundifolia rotundifolia* (Scudder), lateral aspect.

Fig. 115.—Apex of ovipositor of *Nemobius maculatus* Blatchley, lateral aspect.

Fig. 116.—Fastigium of *Neoconocephalus nebrascensis* (Bruner), lateral aspect.

Fig. 117.—Fastigium of *Neoconocephalus exiliscanorus* (Davis), lateral aspect.
Adapted from Rehn and Hebard.

Fig. 118.—Apex of ovipositor of *Nemobius carolinus carolinus* Scudder, lateral aspect.

Fig. 119.—Apex of ovipositor of *Nemobius confusus* Blatchley, lateral aspect.

Fig. 120.—Fastigium of *Neoconocephalus triops* (Linnaeus), ventral aspect.

Fig. 121.—Fastigium of *Neoconocephalus retusus* (Scudder), ventral aspect.

Fig. 122.—Fastigium of *Neoconocephalus robustus robustus* (Scudder), ventral aspect.

Fig. 123.—Fastigium of *Neoconocephalus robustus crepitans* Scudder, ventral aspect.

Fig. 124.—Apex of ovipositor of *Nemobius cubensis palustris* Blatchley, lateral aspect.

Fig. 125.—Apex of ovipositor of *Nemobius fasciatus fasciatus* (DeGeer), lateral aspect.

Fig. 126.—Fastigium of *Neoconocephalus ensiger* (Harris), ventral aspect.

Fig. 127.—Fastigium of *Neoconocephalus palustris* (Blatchley), ventral aspect.

Fig. 128.—Fastigium of *Neoconocephalus lyristes* (Rehn and Hebard), ventral aspect.

Fig. 129.—Fastigium of *Neoconocephalus nebrascensis* (Bruner), ventral aspect.

Fig. 130.—Fastigium of *Neoconocephalus exiliscanorus* (Davis), ventral aspect.
Adapted from Blatchley.

Fig. 131.—Cercus of male *Conocephalus brevipennis* (Scudder), dorsal aspect.

Fig. 132.—Cercus of male *Conocephalus fasciatus fasciatus* (DeGeer), dorsal aspect.

Fig. 133.—Cercus of male *Orchelimum silvaticum* McNeill, dorsal aspect.

Fig. 134.—Cercus of male *Orchelimum nigripes* Scudder, dorsal aspect.

Fig. 135.—Cercus of male *Conocephalus attenuatus* (Scudder), dorsal aspect.

Fig. 136.—Cercus of male *Conocephalus nemoralis* (Scudder), dorsal aspect.

Fig. 137.—Cercus of male *Orchelimum concinnum concinnum* Scudder, dorsal aspect.

Fig. 138.—Cercus of male *Orchelimum vulgare* Harris, dorsal aspect.

Fig. 139.—Cercus of male *Conocephalus strictus* (Scudder), dorsal aspect.

Fig. 140.—Cercus of male *Orchelimum bullatum* Rehn and Hebard, dorsal aspect.

Fig. 141.—Cercus of *Orchelimum gladiator* (Bruner), dorsal aspect.

ABBREVIATION

h—humeral sinus

KEY TO THE ORDERS

- Body terminated caudad in a pair of elongate forceps, figs. 142-145. Tegmina present, always very short and without apparent veins, fig. 150, p. 151 **Dermaptera**, p. 151
- Body not terminated caudad in a pair of forceps, figs. 146-149. Tegmina present or absent; when present with distinct veins, fig. 32 **Orthoptera**, p. 151

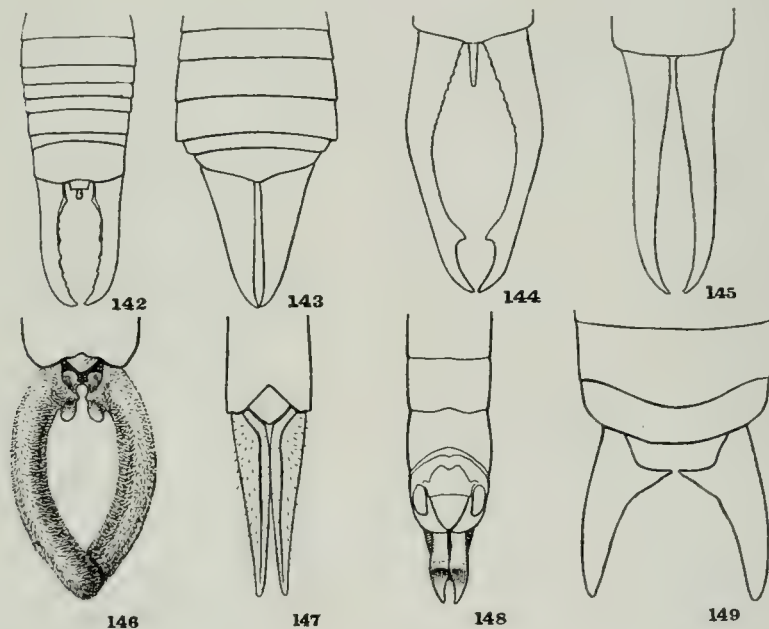


PLATE V

APEX OF ABDOMEN OF DERMAPTERA AND ORTHOPTERA

- Fig. 142.—*Labia minor* (Linnaeus), male.
- Fig. 143.—*Labia minor* (Linnaeus), female.
- Fig. 144.—*Doru aculeatum aculeatum* Scudder, male.
- Fig. 145.—*Doru aculeatum aculeatum* Scudder, female.
- Fig. 146.—*Diapheromera blatchleyi blatchleyi* (Caudell), male.
- Fig. 147.—*Diapheromera blatchleyi blatchleyi* (Caudell), female.
- Fig. 148.—*Melanoplus mexicanus mexicanus* Sausure, female.
- Fig. 149.—*Conocephalus strictus* Scudder, male.

DERMAPTERA

THIS ORDER is represented in the state by two species which are members of separate families, and an additional adventive.

KEY TO FAMILIES

- Second tarsal segment cylindrical. Very small. Generally buffy brown. Macropterous.
 Introduced species.....**LABIIDAE**
- Second tarsal segment heart shaped. Small. Generally deep red-brown, tegmina and legs paler. Brachypterous, very rarely macropterous.....**FORFICULIDAE**

LABIIDAE**Labia** Leach

L. minor (Linnaeus).—This is an introduced species, widespread throughout the United States.

Lake Forest: 1♂, *HC*. **Algonquin:** May 13, 1894, 1♀, Nason; Oct. 1908, 1♂, Nason. **Havana:** Aug. 16, 1898, 1♂ on houseboat. **Urbana:** 1♀; June 5, 1926, 1♂, Park. **Dubois:** 1907, 1♂.

FORFICULIDAE**Doru** Burr

D. aculeatum aculeatum (Scudder).—Thomas (1876) recorded this species as *Forficula aculeata* from northern Illinois. It has not been captured in the state since then. It occurs in sedges and high marsh grasses and has also been found beneath rubbish and leaves in woods.

D. lineare (Escholtz).—This species has been captured as an adventive in the state.

The only record is a single female with egg mass found at **Urbana**, April 8, 1933, in a cabbage shipped from Texas.

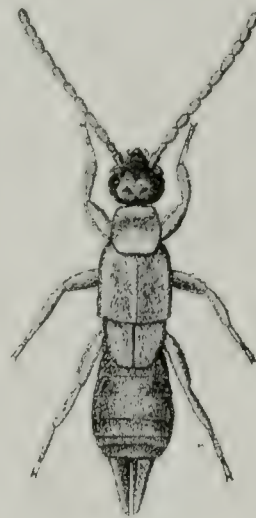


Fig. 150.—Adult female of *Labia minor* (Linnaeus), an earwig which occurs widely throughout the United States. $\times 6$.

ORTHOPTERA

THIS ORDER is represented in Illinois by 191 species and races. In addition to this number seven species of cockroaches have been found adventive in the state.

KEY TO FAMILIES

1. Legs nearly equal in size, the caudal femora not distinctly enlarged for leaping, fig. 152, p. 159.....2
 Caudal legs elongate, their femora enlarged for leaping, fig. 157, p. 188.....4
2. Cephalic legs not highly developed for grasping, fig. 154, p. 161.....3
 Cephalic legs highly specialized for grasping, fig. 152, p. 159. .**MANTIDAE**, p. 158

ORTHOPTERA—KEY TO FAMILIES—CONT'D

3. Body strongly depressed, broad, often more or less oval in dorsal aspect, fig. 151, p. 156.....**BLATTIDAE**, p. 152
Body elongate and slender, fig. 154, p. 161.....**PHASMIDAE**, p. 159
4. Antennae much shorter than body and relatively heavy, fig. 155, p. 169, and cephalic legs never specialized for digging. Auditory organs lateroproximad on abdomen when present. Stridulating organs of male on caudal femora and adjacent portion of tegmina when present. Ovipositor composed of two pairs of short curved pieces with acute tips.....**ACRIDIDAE**, p. 162
Antennae extremely slender, much longer than body, fig. 158, p. 207, except in *GRYLLOTALPINAE* and *TRIDACTYLINAE* which have cephalic legs specialized for digging. Auditory organs when present proximad on cephalic tibiae. Stridulating organ of male when present in anal fields of tegmina. Ovipositor when exerted forming an elongate blade or tube.....5
5. Tarsi four segmented. Tegmina where present sloping at sides of body with much smaller deplanate dorsal section including only anal fields.....**TETTIGONIIDAE**, p. 200
Tarsi three segmented, or less in *Tridactylus*. Tegmina where present horizontal in greater part, the narrow lateral portions alone bent downward. Ovipositor when exerted forming a slender tube with apex enlarged, bladelike only in *TRIGONIDIINAE*.....**GRYLLIDAE**, p. 243

BLATTIDAE

KEY TO SUBFAMILIES AND GENERA

1. Ventral margins of femora heavily armed (*PSEUDOMOPINAE*, p. 153)....2
Ventral margins of femora unarmed (*PANCHLORINAE*)...**Pycnoscelus**, p. 157
2. Ventrocephalic margin of cephalic femora armed proximad with a row of heavy spines, succeeded by a row of much more slender shorter spines, fig. 7....3
Ventrocephalic margin of cephalic femora armed with a row of heavy spines which gradually decrease in size distad, fig. 8.....4
3. Male with sixth tergite specialized mesad, this flanked by a pair of minute toothed, comblike processes, fig. 13. Structure moderately delicate. Female with pronotum entirely brownish black, with tegmina meeting on meson. General coloration blackish brown, limbs and often tegmina paler, more reddish. Male with fully developed organs of flight, female with subquadrate, overlapping tegmina. Medium small.....**Ischnoptera**, p. 153
Male without comblike processes flanking specialization of sixth tergite. Female with pronotum varied with light brown or tegmina not meeting on meson.....**Parcoblatta**, p. 153
4. General coloration buffy, pronotum with a pair of dark longitudinal bands. Structure delicate. Small. Organs of flight fully developed. Introduced, domiciliary.....**Blattella**, p. 153
General coloration dark, pronotum without a pair of darker longitudinal bands. Structure heavily chitinous. Much larger. (*BLATTINAE*, p. 156).....5
5. Organs of flight fully developed, extending beyond top of abdomen. Large. Arolia well developed.....**Periplaneta**, p. 156
Organs of flight moderately reduced in male, represented by lateral pads in female. Medium large. Arolia subobsolete. Introduced, domiciliary....**Blatta**, p. 157

PSEUDOMOPINAE

Blattella Caudell

B. germanica (Linnaeus).—This cosmopolitan species is one of the commonest household and restaurant pests encountered in the state.

Chicago: Apr. 28, 1906 and May 7, 1907, 2♀. **Algonquin:** Oct. 8, 1907, 4♂, 7♀, 1 juv. ♀, Nason. **St. Joseph:** July 29, 1919, 1♀. **Urbana:** June 5, 1926, 2♂, 1 juv., Frison; July 11, 1911, 1♀, 1 juv. **Champaign:** Oct. 20, 1891, 2♀ in bakery, Marten. **Bluffs:** Aug. 30, 1905, 1♀. **Harrisburg:** Aug. 13, 1905, 4♂, 1♀, 5 juv.

Ischnoptera Burmeister

I. deropeltiformis (Brunner).—These are the first records from Illinois, the species being undoubtedly limited to the extreme southern portion of the state.

Fountain Bluff: May 15, 1932, 1♀, 1 large juv. ♀, Frison, Ross and Mohr. **Grand Tower:** June 28, 1906, 2♀.

Parcoblatta Hebard

Thomas and McNeill recognized only two species which are referable to *Parcoblatta*, *i. e.*, the pale *unicolor* (a synonym of *uhleriana*) and the strikingly colored *pennsylvanica*, both of which were referred to *Ischnoptera*. Their material of "unicolor" cannot be referred with any certainty to any one of the six paler species of *Parcoblatta* now known to occur in Illinois.

KEY TO SPECIES

1. Tegmina extending beyond apex of abdomen (males).....2
Tegmina not reaching apex of abdomen (females).....8
2. Dorsal surface of abdomen not specialized, lacking patches of setae, elevations or depressions, fig. 9. Ochraceous buff, head and sometimes pronotum much darker.....**bolliana**, p. 154
Dorsal surface of abdomen specialized, having patches of setae, elevations or depressions, fig. 10. Small to medium small.....3
3. Median segment (first abdominal tergite) alone specialized.....4
Median segment and second abdominal tergite each with twin specialized areas. Medium small.....7
4. Median segment having a single specialized area.....5
Median segment having twin agglutinated tufts of hairs. Medium small. Generally testaceous.....6
5. Median segment of abdomen with a tuft of agglutinated hairs. Generally testaceous, the pronotum often suffused laterad.....**zebra**, p. 154
Median segment of abdomen with mesal portion extensively supplied with minute scattered hairs. Generally ochraceous buff.....**virginica**, p. 154
6. Cerci with inner distal angles of sixth to ninth joints acutely though briefly produced, fig. 11.....**uhleriana**, p. 155
Male cerci simple, fig. 12.....**fulvescens**, p. 155

PARCOBLATTA—KEY TO SPECIES—CONT'D

7. Specialized area of abdomen represented by slight elevations with a heavy tuft of hairs. Testaceous..... *lata*, p. 155
Specialized areas of abdomen represented by decided overhanging elevations with ventral surfaces of apices heavily supplied with hairs. Coloration wood brown with pronotum often very dark with pale lateral and cephalic margins..... *pennsylvanica*, p. 156
8. Tegmina not meeting on meson..... 9
Tegmina meeting or overlapping on meson..... 10
9. Tegmina very small, scarcely projecting beyond mesonotum, and separated by nearly twice their width..... *bolliana*, p. 154
Tegmina reaching first segment of abdomen, separated by less than their width..... *uhleriana*, p. 155
10. Dorsum of abdomen banded, bases of tergites black with lateral, apical and sometimes mesal portions yellowish..... *zebra*, p. 154
Dorsum of abdomen more or less unicolorous, composed of shades of brown or blackish brown..... 11
11. Tegmina not more than 3 mm. long..... *virginica*, p. 154
Tegmina at least 4 mm. long..... 12
12. Pronotum wood brown with well defined yellow marginal band. Tegmina usually extending to or beyond middle of abdomen.... *pennsylvanica*, p. 156
Pronotum with pale lateral band absent or gradually merging with ground color, poorly defined. Tegmina never reaching middle of abdomen..... 13
13. Posterolateral angle of tegmina somewhat quadrate, fig. 15... *fulvescens*, p. 155
Posterolateral angle of tegmina more rounded, fig. 14..... *lata*, p. 155

P. bolliana (Saussure and Zehntner).—Occurs only in southern and central Illinois, with Charleston and Clay City as northern known limits.

Charleston: June 11, 1931, 2♂, Ross. **Clay City:** June 23, 1909, 2♂ at light. **East St. Louis:** June 26, 1931, 1♂, Frison. **Dubois:** June 22, 1905 and July 2, 1909, 2♂ at light. **Carbondale:** May 27, 1909, 1♀ on persimmon tree; June 28, 1907, 1♂ at light. **Prospect Hill:** June 29, 1905, 1♀. **Parker:** June 7, 1913, 1♂.

P. zebra Hebard.—Described in 1917, the type of *zebra* came from Pulaski, the allotype from Havana, Illinois. Other material was then recorded from Knox county, Ind., Rives, Tenn., Lakeview and Hattiesburg, Miss., West Monroe and Mansura, La., and Dallas and Victoria, Tex. The species is evidently common in southern Illinois, Havana being a northern limit point in its distribution.

Havana: June 1 to Aug. 14, 1907 to 1911, 10♀, majority Aug. 14 on river shore; June 27 and July 8, 1910, 2♂, **Pike:** May 25 and 26, 1906, 3 juv.♂ in last instar, 5 juv.♀ in preceding instar, 1 juv.♀ in instar preceding that; June 25, 1906, 7♂. **Kampsville:** June 25, 1931, 1♂, Frison. **Mascoutah:** July 17, 1906, 1♀ in woods. **East St. Louis:** July 18, 1906, 2♀, 1 medium juv.♀. **Grand Tower:** June 2, 1913, 6♂ at light; June 28, 1906, 1♀. **Pulaski:** May 29, 1909, 1♀; June 9, 1907, 1♂.

P. virginica (Brunner).—This insect was reported from Rock Island by Hebard in 1917.

Ravinia: June 30, 1907, 1♂, Hood; July 21, 1907, 1♀, Zetek. **Aurora:** June 1908, 2♂ on hazel. **Danville:** July 7, 1906, 2♀ in woods. **Muncie:** June 13 to 16, 1905 and 1907, 8♂, 12♀. **Homer:** May 26, 1905, 2♂. **Urbana:** June 28, 1907, 1♂ in woods. **White Heath:** June 18, 1906, 1♂ in woods. **Charleston:** June 11, 1931, 1♂, Ross. **Pike:** June 25, 1906, 3♂. **Mt. Carmel:** July 2, 1906, 7♀. **Dubois:** June 21, 1905, 2♂, 5♀. **Carbondale:** June 26, 1907, 1♂. **Grand Tower:** June 2 to 28, 1906 and 1913, 3♂, 1♀. **Parker:** June 7, 1913, 1♂; June 12, 1907, 2♀. **Cobden:** June 29, 1905, 1♀. **Pulaski:** June 9 and 10, 1907, 1♂, 1♀, on bluff.

P. uhleriana (Saussure).—Recorded from Mossville by Hebard in 1917, the species is distributed over most of Illinois, Savanna being a northern point.

Savanna: July 27, 1892, 1♀, Hart and Forbes. **Muncie:** June 13, 1905, 1♂; July 6, 1907, 2♀. **Oakwood:** June 6, 1925, 1♂, Frison. **Homer:** July 20, 1907, 1♀. **Centralia:** June 15, 1905, 1♂. **Carbondale:** May 18, 1910, 1♂ on hickory; June 26, 1907, 1♀. **Parker:** June 7 to 12, 1907 and 1913, 2♂, 1♀. **Saratoga II:** July 17, 1877, 1♀. **Pulaski:** May 26 to June 10, 1907, 3♂.

P. fulvescens (Saussure and Zehntner).

1893 *Ischnoptera uhleriana* var. *fulvescens* Saussure and Zehntner, Biol. Cent.-Am., Orth., vol. 1, p. 36. ♂, in part, Georgia.

Type of *fulvescens* here selected. It is probable that the original figures, certainly those of the female, are based on Texan material, all from Dallas and probably representing *zebra*, though specimens of *fulvescens* may be included in the series from there as it is known from that locality. The New Mexican material originally recorded cannot be placed without examination of the specimens. We do not believe however that either *fulvescens* or *zebra* occur in that state but it is likely that *desertae* is actually represented.

We here select a male from Georgia in the Geneva Museum as type of *fulvescens*. A paratype male, labeled simply "Ga.," has been received by us in exchange with that institution. We also received in the same exchange another paratype male from Dallas, Tex., which however represents *zebra*, as did the originally figured female from "Texas," probably also from Dallas. Thus we know that the originally described *fulvescens* was a composite in which males of both *fulvescens* and *zebra* were included.

The species is probably confined to extreme southern Illinois, the following being northern limit records.

Prospect Hill: June 29, 1905, 1♀. **Cobden:** June 26, 1905, 1♀.

P. lata (Brunner).—Limited to southern Illinois; Mt. Carmel and Dubois are northern points of distribution.

Mt. Carmel: July 2, 1906, 1♂, 1♀. **Dubois:** June 21, 1905 and July 9, 1909, 3♀. **Carbondale:** June 22 and 26, 1907, 2♂, 2♀. **Cobden:** July 17, 1905, 1♂. **Whitehill:** June 29, 1905, 1♀. **Pulaski:** June 9, 1907, 1♂, 1♀, on bluff.

P. pennsylvanica (DeGeer).—This insect is distributed generally and is decidedly the most abundant native cockroach throughout the state.

Beach: Aug. 22, 1906, 1♀ on sand ridges. **Chicago:** Feb. 4, 1906, 1♂ in Lincoln Park greenhouse. **Algonquin:** May 1 to July 24, 1905 to 1909, 9♂.

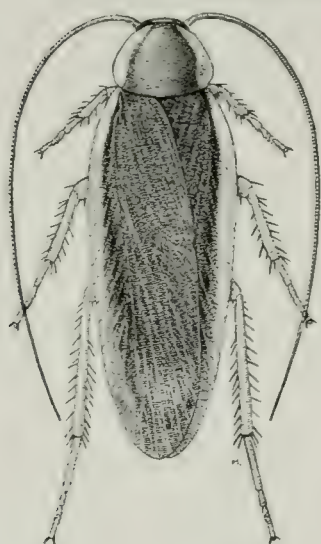


Fig. 151.—An adult male of *Parcoblatta pennsylvanica* (DeGeer), the most abundant native cockroach in Illinois. $\times 1.7$.

Oregon: June 19, 1917, 1♂, 1♀. **Summit:** July 20, 1907, 1♀, Zetek. **Aurora:** June 1908, 1♂, 1♀, *in coitu* on oak. **Sparland:** June 3, 1933, 1♂, Mohr. **Rock Island:** May 21, 1928, 1♂. **Monmouth:** Apr. 2, 1928, 1 nymph, Frison and Ross. **Peoria:** June 1879, 1 large juv. ♂, TC. **Danvers:** May 27, 1932, 1♀, Frison. **Leslie:** May 1881, 1♂. **Elliott:** July 10, 1906, 3♀. **Topeka:** Aug. 22, 1904, 1♀, Hart and Brown. **Devil's Hole:** June 8, 1905, 1♂. **Havana:** June 9 to Aug. 15, 1905 to 1928, 9♂, 18♀. **Danville:** July 7, 1906, 3♀. **Muncie:** May 10, 1906, 1 large juv. ♂; June 13 to 15, 1905, 8♂, 9♀. **Homer:** May 26 to June 24, 1905 to 1926, 13♂, 4♀. **Urbana:** Jan. 16 to May 21, 1906 and 1926, 7 juv.; June 1 to July 20, 1885 to 1909, 4♂, 8♀. **Champaign:** May 29, 1886, 1♂, Weed. **White Heath:** June 18, 1906, 1♀. **Matanzas Lake:** Aug. 23, 1894, 1♀, Forbes. **Camargo:** June 13, 1900, 1♂, 1♀, Myers. **Pike:** May 26 and June 25, 1906, 2♂, 3♀, 1 large juv. ♀. **Alma:** June 24, 1902, 2♀, Titus. **Centralia:** Aug. 28, 1905, 2♀. **Mascoutah:** July 17, 1906, 2♀. **Mt. Carmel:** July 2, 1906, 2♀. **Dubois:** July 5 and 9, 1909, 2♀ swept from grass. **Shawneetown:** Apr. 23, 1926, 2 large juv. ♂, Frison. **Carbondale:** Apr. 1882, 1♂. **Grand Tower:** June 2, 1913, 1♂ in woods at night; June 28, 1906, 1♀. **Pulaski:** May 26, 1907, 1 large juv. ♀ on bluff.

BLATTINAE

Periplaneta Burmeister

KEY TO SPECIES

Solid shining blackish brown. Dorsal surface of male abdomen with median segment specialized mesad. Male supra-anal plate chitinous, specialized ventrad. Introduced, domiciliary.....**fuliginosa**, p. 156

Reddish brown with pronotal disk paler with twin large suffusions of reddish brown. Dorsal surface of male abdomen unspecialized. Male supra-anal plate delicate, lamellate produced, not specialized ventrad. Introduced, domiciliary.....**americana**, p. 157

P. fuliginosa (Serville).—The only record for the state is a series of 13 males and 14 females taken at Chicago, March 1, 1906. This series is probably from a colony established by material accidentally introduced by commerce. This is probably analogous to the colony of *Periplaneta australasiae* which has been reported from Radnor, Pa. Such colonies, although thoroughly established locally, are not liable to spread in these latitudes. However both these species can be introduced and become very

generally distributed in tropical and subtropical regions. The present species was not known to have established itself north of Florida.

P. americana (Linnaeus).—This is also not a native species, but unlike the other two discussed it is known to be found quite often this far north. Though probably less abundant in the tropics than *australasiae*, it is usually the most abundant species of the genus in subtropical regions.

Chicago: May 20, 1922 and July 16, 1923, 1♂, 1♀, Abbey, in museum; Gueret *FM*. **Normal:** Nov. 1882, 1♂ in ditch. **Champaign:** Jan. 13, 1928, 1♂ in house. **Decatur:** Nov. 3, 1916, 1♂ in house. **Quincy:** Sept. 12, 1904, 3♂, Mosier; Oct. 6, 1903, 1♀, Taylor and Hart.

P. australasiae (Fabricius), a third species, is almost certain to be found introduced at Chicago. The coloration is much as in *americana* but much brighter and in sharper contrasts, the male supra-anal process is much as in *fuliginosa* but is unspecialized ventrad. It also is not native, being a domiciliary adventive in this latitude.

Blatta Linnaeus

B. orientalis Linnaeus.—Though not a native this filthy insect is probably generally distributed and well established throughout the towns and cities of Illinois.

Chicago: Mar. 1, 1906, 1♂ in greenhouse. **Havana:** July 12, 1894, 1♀. **Urbana:** Apr. 21, 1890, 1♂ at light; May 3 to Sept. 1, 1906 to 1931, 3♂, 4♀, at light and in house. **Champaign:** Sept. 30, 1927, 1♀ with oötheca in house. **Harrisburg:** June 25, 1932, 1♂, Ross, Dozier and Park. **Carbondale:** July 21, 1905, 1 medium large juv.♀. **Grand Tower:** June 28, 1906, 1♀.

PANCHLORINAE

Pycnoscelus Scudder

P. surinamensis (Linnaeus).—This is another introduction from tropical and subtropical regions, where the species is common. It can establish itself in greenhouses and similar places and then often appears in large enough numbers to do considerable damage.

Maywood: Feb. 9, 1929, 2 juv.♀ from rose bench, Compton; Apr. 21, 1931, 2♀, 12 juv.♀.

ADVENTIVE BLATTIDAE

Though the following species have been taken in Illinois they are all tropical forms brought into the state in shipments of fruit. As we do not believe that they ever become even locally established, it is best to consider them adventives and omit them in lists of the species from this region.

PSEUDOMOPINAE

Neoblattella detersa (Walker).—**Urbana:** Aug. 30, 1906, 1♂ in bunch of bananas. Source—probably Jamaica.

Supella supellectilium (Serville).—**Urbana:** Jan. 21, 1933, 1♂ in house, Frison. Source—tropical America.

BLATTINAE

Eurycotis floridana (Walker).—Northern Illinois: 1 juv. ♂. Source—southeastern United States.

NYCTIBORINAE

Nyctibora noctivaga Rehn.—Urbana: Dec. 12 and 28, 1925, 2 juv. ♀ in store, E. Decker. Source—Central America.

Nyctibora species, near *noctivaga*.—Algonquin: Sept. 17, 1896, 1 ♀ (determined incorrectly as *holosericea* by Hart), 2 juv. ♀. Mt. Carmel: 1 ♂ (determined incorrectly as *Periplaneta americana* by McNeill) from bananas, Schneck. Source—tropical America.

EPILAMPRINAE

Epilampra adbomen-nigrum (DeGeer).—Urbana: Jan. 6, 1920, 1 ♀ from bananas, Folsom. Source—tropical America.

PANCHLORINAE

Panchlora cubensis Saussure.—Prairie View: 1 ♀ in bananas. Algonquin: Apr. 19 to Dec., 1907 to 1915, 6 ♀ (determined incorrectly as *viridis* by Hart) in bananas, Nason. Elliott: May 16, 1906, 1 ♀ in bananas, Kelly. Urbana: Apr. 4, 1924, 1 ♀ in bananas, Van Cleave. Dubois: Nov. 24, 1913, 1 ♀, Hinkley. Source—tropical America.

MANTIDAE

MANTINAE

KEY TO GENERA

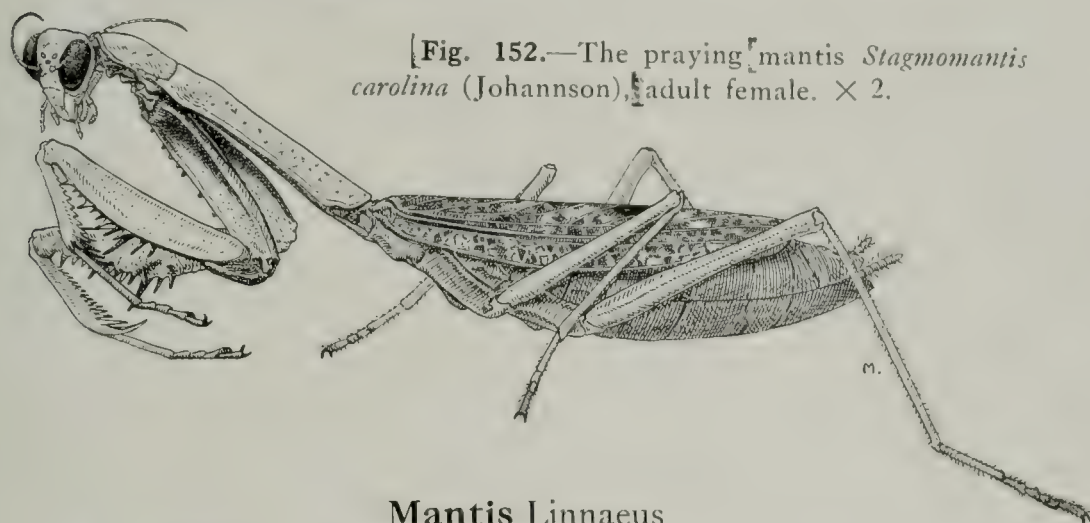
1. Organs of flight fully developed in male with marginal field hyaline, shorter than abdomen in female. Pronotum with supracoxal expansion decided and shaft comparatively slender. Cephalic trochanters immaculate proximointernally, their cephalic margin armed with coarse teeth. Medium size. *Stagmomantis*, p. 158
- Organs of flight fully developed with marginal field opaque in both sexes. Pronotum with supracoxal expansion moderate and shaft comparatively thick. 2
2. Cephalic trochanters with a black inner proximal marking, their cephalic margin finely toothed. Medium size. Introduced species. *Mantis*, p. 159
- Cephalic trochanters immaculate on inner proximal surface, their cephalic margin armed with coarse teeth. Very large. Introduced species. *Tenodera*, p. 159

Stagmomantis Saussure

S. carolina (Johannson).—We believe that both Chicago records which follow are accidental introductions and that the northern limits of this species, the only native Illinois mantid, must be given as Quincy, Olney and Centralia, indicating that it is confined to the southern portion of the state.

Chicago: Aug. 9, 1921, 1 ♀, brown, in Irving Park, Delchmann, *FM*; Oct. 1919, 1 ♀, brown, on lumber car from the south, Kleinpaste, *FM*. **Quincy:** Aug. 4, 1898, 1 medium juv. ♂. **Vandalia:** Sept. 30, 1929, 1 ♀, green, Frison. **Edwardsville:** Sept. 11, 1929, 1 ♀, green, Frison. **Olney:** Sept. 13, 1904, 1 ♀, dark brown, 1 oötheca, Taylor. **Centralia:** Sept. 23, 1886, 1 ♂, Weed. **Waterloo:** Sept. 11, 1929, 1 ♂, Frison. **Keensburg:** Sept. 5, 1927, 1 ♀, very dark brown. **Browns:** Aug. 21, 1902, 1 ♂, Titus. **Ashley:** Sept. 7, 1905, 1 ♂, Taylor. **Dubois:** Mar. 1894, 1 oötheca; June 22, 1905, 1-small juv.

Pinckneyville: Sept. 1887, 1 ♂. **Carbondale:** Oct. 15, 1909, 1 ♀, green, Smith. **Metropolis:** Sept. 3, 1924, 1 ♀, brown, 1 large juv. ♂, Frison; Sept. 28, 1889, 1 ♀, brown, Marten; Sept. 28, 1929, 1 large juv. ♀, Frison. **Pulaski:** Sept. 5 and 10, 1909, 3 ♀, brown, Hart.



[Fig. 152.—The praying mantis *Stagmomantis carolina* (Johannson), adult female. $\times 2$.

Mantis Linnaeus

M. religiosa Linnaeus.—This European species has been intentionally introduced and has become established in northern New York. Whether the record indicates a single introduction or the presence of a colony in northern Illinois remains to be decided.

Chicago: Sept. 10, 1909, 1 ♀, brown, Hart.

Tenodera Burmeister

T. sinensis Saussure.—This very large, interesting and beneficial Asiatic insect was introduced in Philadelphia and has flourished and become quite widely distributed from that source. It has evidently been introduced and become established in Illinois also.

Urbana: Sept. 25, 1920, 1 ♂, Kienholz; fall of 1920, 1 ♀. **Champaign:** Oct. 1, 1916, 1 ♀ in yard. **Dubois:** Aug. 25, 1909, 1 ♂, Vestal. **Equality:** June 19, 1906, 1 oötheca, Gordon.

PHASMIDAE

KEY TO SUBFAMILIES AND GENERA

- Median and caudal femora with a concavity ventrodistad. Body comparatively robust for a walking stick. Brown with a darker mediolongitudinal stripe. Male much smaller and more slender than female. (*ANISOMORPHINAE*).
 **Anisomorpha**, p. 159
- Median and caudal femora not concave ventrodistad. Body very elongate and slender. (*HETERONEMIINAE*).
 **Diapheromera**, p. 160

ANISOMORPHINAE

Anisomorpha Gray

A. ferruginea (Beauvois).—This is a northern limit record. The

specimen was recorded as *buprestoides* by McNeill in 1891, but corrected by Blatchley in 1920.

Saratoga II: July 17, 1877, 3 ♂, 1 ♀, 1 juv. ♂.

HETERONEMIINAE

Diapheromera Gray

KEY TO SPECIES

1. Caudal femora not armed ventrodistad. Male cerci with a slender proximointernal tooth. Female cerci elongate, slightly shorter than the more elongate ultimate tergite. Head much longer than broad. Extremely slender. *blatchleyi blatchleyi*, p. 160
- Caudal femora armed with a stout spine ventrodistad. 2
2. Male with middle femora banded with green and brown. Female cerci short, fig. 153c, less than half the length of tenth tergite. Head slightly longer than broad. Very slender. *femorata*, p. 161
- Male with middle femora unbanded. Female cerci long, as long as tenth tergite. *velii*, p. 162

D. blatchleyi blatchleyi (Caudell).—Much larger series of males of *blatchleyi* now before us from Illinois, as well as two from Missouri (Van Buren, Ozark mountains: July 2, 1930, 1 ♂, Pence, MMZ) and extreme eastern Oklahoma (Adair county: July 10, 1929, 1 ♂, Bird, MMZ), show no convergence whatever toward *persimilis*. Indeed the differences, particularly of the ninth sternite and poculum of the male prove that we were incorrect in assigning the present insect to racial status under *persimilis* (Hebard 1931b).

This, it will be further noted, will transfer the eastern race *atlantica* (Davis) from *persimilis* to *blatchleyi*, as it was originally assigned.

Valid related species are actually represented, distinguished by the following characters.

Both sexes with eighth abdominal tergite distinctly shorter, in male decidedly (to rarely slightly) broader than long. Male with ninth abdominal tergite considerably shorter (length considerably less than $1\frac{1}{2}$ times least width), conspicuously shorter than seventh and expanding weakly distad. Male with portion of ninth sternite before poculum much more ample, nearly as long as broad, the latter very much shorter with proximal portion only moderately constricted and not stalklike. Male with minute slender tooth at inner base of cerci, normally very acute at apex. Male with median femur much more definitely swollen. *persimilis*

Both sexes with eighth abdominal tergite distinctly longer, in male distinctly longer than broad. Male with ninth abdominal tergite considerably longer (length slightly less than twice least width), slightly longer than seventh and expanding very feebly distad. Male with portion of ninth sternite before poculum very narrowly transverse, the latter very elongate with proximal portion decidedly constricted to form a narrow stalk. Male with minute slender tooth at inner base of cerci blunt at apex. Male with median femur very slightly swollen. *blatchleyi blatchleyi*

We would further note that previous records of *blatchleyi* from Missouri, and probably those from Iowa, are correct and not referable to *persimilis* as we suggested in Hebard 1931b.

This interesting and comparatively recently described walking stick is apparently generally distributed throughout northeastern Illinois, Dubois being a limital point southwestward. We have also a brown female from Williams Bay, Lake Geneva, Wis., taken September 3, 1892, by Hart, and constituting a northern limital record.

Beach: Aug. 21, 1906, 1♀, green, in swamp, Hart; Aug. 24 to 29, 1929 and 1932, 4♂. **Waukegan:** Aug. 4, 1930, 4♂, brown, 3♀ and 1 juv.♀, green, Frison, Knight, Ross; Aug. 18 and 20, 1906, 1♂, brown, 1 large juv.♀, green, in swamp, Hart. **Antioch:** Aug. 1, 1930, 1♂, Frison and Knight.

Sun Lake: Aug. 9, 1906, 1 large juv.♂ in bog, Hart. **Volo Lake:**

July 16, 1926, 1 large juv.♂, green, in tamarack bog, Frison and Hayes. **Amboy:** Aug. 25, 1933, 1♀, green, Ross and Mohr. **Bloomington:** Sept. 1875, 1♀. **Topeka:** Aug. 22, 1904, 1♀, green, Hart and Brown. **Havana:** July 22, 1912, 1♀, green; Sept. 18, 1895, 1♀, green. **Urbana:** June 30, 1901, 1♀, 2 medium juv.♀, green. **Monticello:** June 28, 1932, 1 juv.♀, green, Frison. **Mantanzas Lake:** July 11, 1910, 1 large juv.♀, green. **Dubois:** June 22, 1905, 1♂, brown, Hart.

D. femorata (Say).—This is undoubtedly the commonest walking stick in Illinois, found throughout the state. It was correctly recorded by Thomas in 1876, but as the synonym *sayi* by McNeill in 1891.

Winnetka: Aug. 6, 1925, 1♂, Park. **Channel Lake:** Aug. 13, 1906, 1 large juv.♂, Hart. **Algonquin:** July 31, 1905, 1 medium juv.♀, Nason; Aug. 16 to Sept. 13, 1905 and 1906, 4♂, 2♀. **Amboy:** Aug. 25, 1933, 2♂, Ross and Mohr. **Milan:** Aug. 14 to 17, 1885, 1♂. **Danville:** Sept. 28, 1928 and Oct. 24, 1926, 3♂, 2♀. **Muncie:** Sept. 7, 1912, 1♀. **Oakwood:** Sept.

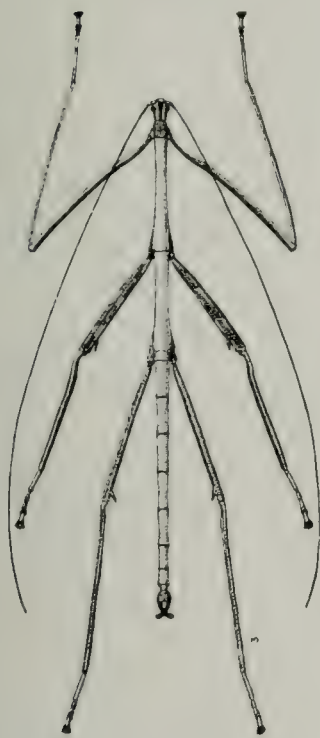


Fig. 154.—A male adult of the commonest walking stick, *Diapheromera femorata* (Say), in Illinois. $\times .7$.

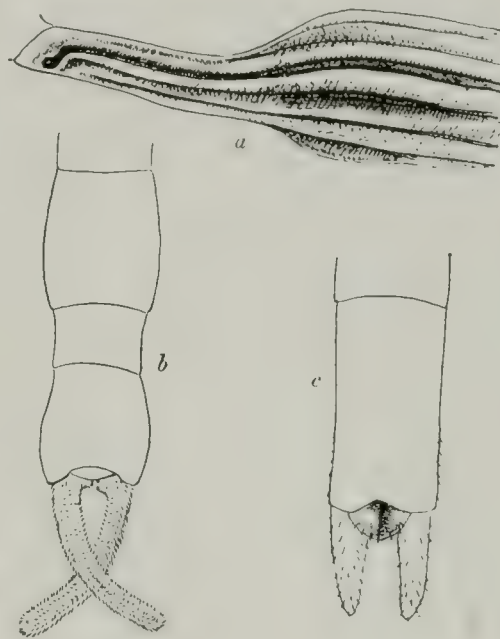


Fig. 153.—Parts of *Diapheromera femorata*. a, middle femora of male; b, terminal abdominal segments and cerci of male; c, terminal abdominal segment and cerci of female.

17, 1928, 2♂, 1♀, Frison. **Homer**: Sept. 24, 1927, 1♂, Frison. **Urbana**: July 27, 1926, 1 medium juv.♀ in woods, Frison; Aug. 1 to Oct. 27, 1885 to 1928, 5♂, 5♀; Sept. 5, 1898, 1 medium juv.♀, Woodworth. **Mahomet**: Aug. 20 to Oct. 2, 1928, 3♂, 1♀. **Quincy**: Oct. 6, 1903, 1♂, Taylor and Hart. **Borton**: Sept. 23, 1932, 1♂, Frison and Ross. **Charleston**: July 16 to 22, 1910, 6♂, 4♀, 2 large juv.♂, 3 large juv.♀, in forest. **Lawrenceville**: Sept. 24, 1932, 5♂, 4♀, Frison and Mohr. **Norris City**: Sept. 9, 1933, 1♀, Ross and Mohr. **Shawneetown**: Oct. 12, 1932, 1♂, Frison and Ross. **Makanda**: Sept. 9, 1908, 1♂, 1♀, Smith. **Herod**: Sept. 27, 1929, 1♂, Frison. **Anna**: Sept. 12, 1883, 1♀. **Elizabethtown**: Oct. 13, 1928, 1♂, Frison. **Metropolis**: Sept. 3, 1924, 1♂, Frison.

D. velii Walsh.—Though Walsh in 1864 originally referred a female from Illinois to his *Diapheromera velii*, it is probable that that specimen actually represented *blatchleyi*. The present insect has not subsequently been secured in the state, but may possibly occur in its west-central portion, as the race *velii velii* has been reported from as far east as Central City and Elmira, Iowa, and Memphis, Mo.—localities not distant from the Mississippi river. The two Iowa records, in addition, are less than a hundred miles from Rock Island, where Walsh's doubtful specimen was collected.

ACRIDIDAE

KEY TO SUBFAMILIES AND GENERA

1. Pronotum covering all or nearly all of abdomen, fig. 155, p. 169. Pulvilli absent. Cephalic and median tarsi with two segments, caudal tarsi with three segments. Comparatively very small species. (*ACRYDIINAE*, p. 166) . . . 2
 Pronotum not covering abdomen, fig. 157, p. 188. Pulvilli present. Tarsi all three segmented. Larger species. 6
2. Antennae with 12-14 segments. Eyes not encroached upon by a convex production of the intervening area dorsad. Tegmina lacking a minute apical dot of buff. 3
 Antennae with 22 segments. Eyes encroached upon by a convex production of the intervening area dorsad. Tegmina with a minute apical dot of buff. *Tettigidea*, p. 171
3. Median carina of pronotum high, cristate, fig. 17; dorsum tectate and longitudinally arched. *Nomotettix*, p. 166
 Median carina of pronotum low, fig. 155, p. 169; dorsum not tectate, gently sloping or flat. 4
4. Fastigium considerably wider than eye, fig. 21. 5
 Fastigium narrower, fig. 16; narrower than (male) to slightly wider than (female) eye, not produced, with cephalic margin concave and median carina slightly projecting. *Paratettix*, p. 170
5. Frontal costa widening slightly ventrad, fig. 27, the interval between its carinae very narrow. Vertex in lateral aspect angulate or rounded angulate. *Acridium*, p. 168
 Frontal costa widening suddenly, fig. 28, so that ventrad the interval between its carinae is broad. Vertex in lateral aspect broadly rounded. *Neotettix*, p. 170

ACRIDIDAE—KEY TO SUBFAMILIES AND GENERA—CONT'D

6. Prosternum not spined; flat, convex or with an obtuse tubercle.....7
 Prosternum with a median spine. (*CYRTACANTHACRINAE*, p. 187).....29
7. Disk of pronotum with caudal margin not or but little produced, truncate or convex, figs. 37, 38. Median carina threadlike, only imperceptibly raised above surface of disk. Face usually retreating ventrad and angulate at junction of fastigium. (*ACRIDINAE*, p. 173).....8
 Disk of pronotum with caudal margin strongly produced, acute or nearly so, fig. 40, usually with a raised crestlike median carina, elevated at least in prozonal portion. Face usually nearly vertical and rounding into vertex. (*OEDIPODINAE*, p. 179).....19
8. Lateral foveolae of vertex not visible from above. Stridulating organs present on male caudal femora and tegmina.....9
 Lateral foveolae of vertex visible from above.....17
9. Antennae strongly ensiform, fig. 26.....10
 Antennae cylindrical, fig. 24, or slightly flattened or clavate, fig. 25, never decidedly ensiform.....12
10. Apices of tegmina oblique, fig. 31. Wings of male fenestrate. Caudal femora with genicular areas weakly roundly produced in dorsal portion on each side. Swamp inhabitant.....*Truxalis*, p. 173
 Apices of tegmina rounded, normal, fig. 30. Wings of male not fenestrate. Caudal femora with genicular areas not produced, normal.....11
11. Tegmina with six or more adjacent, regular, longitudinal veins along basal portion of marginal field, fig. 29. Fastigium with lateral portions overhanging and with a distinct mediolongitudinal carina. Male subgenital plate nearly twice as long as preceding sternite. Organs of flight decidedly (male) or greatly (female) reduced, very rarely submacropterous. Form very slender.....*Pseudopomala*, p. 173
 Tegmina with few veins in marginal field, fig. 32. Fastigium with lateral portions not overhanging and with mediolongitudinal carina subobsolete or absent. Male subgenital plate not as long as preceding sternite. Organs of flight fully developed. Form slender.....*Mermiria*, p. 174
12. Fastigium with surface largely convex, lacking a conspicuous inframarginal impression, fig. 35. Supplementary carinae present on head or pronotum or both, except in individuals of *Amphitornus* and *Eritettix* in which the pronotal disk is uniform in color. Tegmina and wings fully developed...13
 Fastigium with surface deplanate or concave or convex with a conspicuous inframarginal impression, fig. 34. Supplementary carinae never developed.....15
13. Inner spurs of caudal tibiae equal.....14
 Inner spurs of caudal tibiae decidedly unequal. Antennae decidedly clubbed at apices in male, weakly so in female.....*Eritettix*, p. 175
14. Caudal tibiae buff, brown or black, with more numerous (15–24) external spines. Antennae slender, moderately elongate, showing a trace of distal thickening in male. Legs elongate. Male medium sized, graceful; female decidedly larger and heavier.....*Syrbula*, p. 174
 Caudal tibiae pale blue with fewer (12–15) external spines. Antennae slightly flattened, of medium length. Legs normal. Smaller, form more compact, slender; much less contrast between the sexes.....*Amphitornus*, p. 175

ACRIDIDAE—KEY TO SUBFAMILIES AND GENERA—CONT'D

15. Fastigium with a conspicuous inframarginal depression, lacking a mediolongitudinal carina. 16
 Fastigium deplanate, with a weak mediolongitudinal carina best indicated distad but occasionally absent, due to individual variation. Lateral lobes of pronotum of male shining black. Organs of flight considerably reduced (male) or greatly reduced (normal female), rarely macropterous in female only. **Chloealtis**, p. 177
16. Lateral lobes of pronotum curving to meet disk, the two forming a rounded arc where they meet. Disk flared out caudally, with mediolongitudinal and lateral carinae weaker, fig. 38. Structure graceful. **Orphulella**, p. 176
 Lateral lobes of pronotum deplanate and nearly vertical, forming a sharp angle with the disk. Disk rectangular and deplanate with mediolongitudinal and lateral carinae decided, fig. 37. Structure heavier. **Dichromorpha**, p. 176
17. Male stridulating rasp on inner surface of caudal femora. Small species, males less than 20 mm., females less than 25 mm. in length. 18
 Male stridulating rasp on tegmina. Larger species, males more than 25 mm., females more than 35 mm. in length. Marsh inhabitants. **Stethophyma**, p. 178
18. Caudal tibiae yellow or buffy. Tegmina with marginal field fenestrate in male. Lateral carinae of pronotal disk arcuate constricted. Form graceful. **Chorthippus**, p. 177
 Caudal tibiae pink. Tegmina with marginal field not fenestrate in male. Lateral carinae of pronotal disk very weak, considerably constricted. Form more robust. **Ageneotettix**, p. 178
19. Wings black with a whitish border. **Dissosteira**, p. 184
 Wings not black. 20
20. Wings with disk nearly or quite transparent. 21
 Wings with disk opaque, colored and plainly bordered by a dark band. 23
21. Pronotum with prozona tectate with lateral carinae absent. Wings usually faintly clouded with dusky cephalad of median portion of peripheral margin. **Chortophaga**, p. 180
 Pronotum with prozona relatively flat, the lateral carinae conspicuous. 22
22. Pronotum with median carina high, prozona nearly as extensive as metazona, fig. 43. Wings very faintly clouded with dusky at tip, the disk very faintly tinged with yellow. **Encoptolophus**, p. 181
 Pronotum with median carina low, prozona much smaller than metazona, fig. 44. Wings very faintly clouded with dusky at tip, the disk transparent, colorless. **Camnula**, p. 181
23. Pronotum with median carina entire, fig. 47, not incised. **Arphia**, p. 179
 Pronotum with median carina incised. 24
24. Median carina of pronotum with a single incision, fig. 45. 25
 Median carina of pronotum with two incisions, fig. 42. 27
25. Incision of median carina of pronotum occurring near middle of pronotum, fig. 45. **Hippiscus**, p. 181
 Incision of median carina of pronotum occurring distinctly cephalad of middle of pronotum, fig. 46. 26

ACRIDIDAE—KEY TO SUBFAMILIES AND GENERA—CONT'D

26. Pronotum with disk coarsely rugose. Body and tegmina irregularly barred with black and gray.....**Pardalophora**, p. 182
 Pronotum with disk smooth or very finely punctured. Body and tegmina more or less unicolorous or of an irregularly speckled appearance.....**Spharagamon**, p. 184
27. Antennae simple, fig. 24. Wing disk yellow.....28
 Antennae subensiform, fig. 23. Wing disk individually pink, through orange to flame scarlet. Prozona not ascending, occiput normal. Frontal costa extremely narrow dorsad. Caudal tibiae with postproximal and apical suffusions of brown, the interval between buff or faintly bluish. Small.....**Psinidia**, p. 185
28. Prozona ascending to the elevated occiput, fig. 36. Wing disk lemon yellow. Frontal costa moderately narrow dorsad. Caudal tibiae buff or light glaucous, without a postproximal annulus. Small....**Trachyrhachis**, p. 184
 Prozona not ascending, occiput normal, fig. 41. Wing disk light yellow, band moderately broad. Medium size.....**Trimerotropis**, p. 186
29. Antennae ensiform, fig. 26. Fastigium very strongly produced. Face extremely oblique. Tegmina extremely elongate and slender with acute apices. Cephalic and median limbs very short. Form very elongate, subcylindrical. Swamp inhabitant.....**Leptysma**, p. 187
 Antennae cylindrical, fig. 24. Fastigium little produced. Face nearly vertical. Tegmina not nearly as elongate and slender. Cephalic and median legs normal. Form not as elongate.....30
30. Mesosternum with caudolateral lobes longer than wide, fig. 52. Male subgenital plate deeply notched. Organs of flight fully developed. Females decidedly larger than males.....**Schistocerca**, p. 187
 Mesosternum with caudolateral lobes as wide as long, fig. 56.....31
31. Vertex broad, fastigium scarcely projecting beyond eye, fig. 61. Form robust. Pronotum with sulci deep; caudal margin of disk very broadly convex, almost truncate. Tegmina represented by pads which are sometimes very briefly acute, but fully developed organs of flight are also occasionally present. Arboreal, oak inhabitant.....**Dendrotettix**, p. 199
 Vertex narrower, fastigium projecting markedly beyond eye, fig. 63.....32
32. Head of normal size, fig. 63.....33
 Head disproportionately large, fig. 62. Form graceful. Pronotum with sulci normal, less decided; caudal margin of disk broadly obtuse-angulate, weakly produced. Tegmina represented by acute pads, but fully developed organs of flight occasionally present. Campestran....**Phoetaliotes**, p. 199
33. Pronotum distinctly rugose and hoary with fine white pile.....**Campylacantha**, p. 189
 Pronotum either not rugose or not hoary.....34
34. General coloration green and pronotum at most with a narrow black band along lateral lobes.....**Hesperotettix**, p. 189
 Either general color not green or pronotum with entire upper half of lateral lobes black.....35
35. Disk of pronotum twice as long as its average width.....36
 Disk of pronotum less than twice as long as its average width.....**Melanoplus** in part, p. 190

ACRIDIDAE—KEY TO SUBFAMILIES AND GENERA—CONCL'D

36. Tegmina much abbreviated, not more than twice as long as wide. **Melanoplus** in part, p. 190
 Tegmina at least three times as long as wide. Male cerci with spatulate apices.
 Male furcula well developed. Caudal tibiae dull pale greenish glaucous.
 Swamp loving species. **Paroxya**, p. 200

ACRYDIINAE

Nomotettix Morse

KEY TO SPECIES

1. Projection of vertex in lateral aspect narrower and longer, fig. 19. Very small.
 Pronotal carina lower. Fastigium more triangularly produced. . **parvus**, p. 166
 Projection of vertex in lateral aspect broader and shorter, fig. 20. Small. Pronotal
 carina higher. Fastigium less produced with sides convex. 2
2. Pronotal carina high, fig. 17. Surface of pronotum comparatively smooth.
 Northern race. **cristatus cristatus**, p. 166⁴
 Pronotal carina very high, fig. 18. 3
3. Surface of pronotum comparatively smooth. Pronotal carina highest for the
 species. More southern race. **cristatus compressus**, p. 167
 Surface of pronotum tuberculate. Pronotal carina slightly lower than in alternate
 category. Southwestern race. **cristatus denticulatus**, p. 168

N. parvus Morse.—The Illinois specimens agree closely with material from northeastern Kansas and south-central eastern Minnesota and are quickly separable from any of the races of *cristatus* by the more projecting vertex which in lateral aspect is narrower, the more coarsely rugose and tuberculate dorsal surface of the pronotum and its low crest which shows scarcely any arcuation except cephalad. The present specimens offer strong evidence that *parvus* is a distinct species. An established synonym is *acuminatus* Hancock.

Snyder: Apr. 14, 1930, 2♂, 2♀, 1 juv.♂, Frison and Ross. **Robinson:**
 Apr. 14, 1930, 3♀, Frison and Ross.

N. cristatus cristatus Scudder.

- 1899 *Nomotettix sinuifrons* Hancock, Ent. News, vol. 10, no. 10, p. 278. ♂,♀, St. Anthony Park, Minn.
 1909 *Nomotettix borealis* Walker, Canadian Ent., vol. 41, no. 6, p. 173, pl. 7, figs. 1 and 1a. ♀, Diamond Lake in Temagami District, Ont.

Rehn and Hebard (1916b) recognized five races of this species, all found in eastern North America, the northernmost of which was considered to be Walker's *borealis*. In 1920 Batchley placed that name in synonymy under *sinuifrons*.

We have examined the type of *borealis*, belonging to Dr. Walker, and that of *sinuifrons*, now in the author's collection. Additional ma-

⁴The races of *Nomotettix cristatus* cannot be distinguished by use of a short key alone.

terial from the more northern portions of the range of *cristatus* shows conclusively that both these names must be synonymized under *cristatus cristatus*. The degree of the production of the vertex is individually variable, even greater contrast than shown by Walker's type as compared with specimens of typical *cristatus cristatus* being found in two cases in material of the same series before us (Wellesley, Mass.; Lake Itaska, Minn.). The emargination of the frontal costa, antennal length and production of cephalic margin and roughness of pronotum are all differences of slight degree and likewise variously combined in other material of the same series before us.

In 1925a we referred to *cristatus cristatus* Rehn's Lakehurst, N. J. record of *sinuifrons* (Smith 1910), and incorrectly recorded as *sinuifrons* three specimens of *Acridium acadicum acadicum* as follows: an immature from St. Anthony Park, Minn., an immature from Brookings, S. D. and a caudate adult from Gull Lake, Muskoka District, Ont. An immature female then recorded from Custer, S. D. fixes the known northwestern limit of *cristatus cristatus*.

Hancock's 1902 records of *compressus* from Indiana were based on a large series of typical *cristatus* from Dune Park, a male probably the same from Clark, and a series intermediate between *cristatus cristatus* and *cristatus compressus* from Vigo county.

This race is probably distributed over most of Illinois. Further collecting is needed to determine its limits definitely and those of *cristatus denticulatus* as well.

Odin: May 10, 1910, 32♂, 1 caudate, 22♀, in meadow. **Mt. Carmel:** May 28, 1884, 1♂. **Dubois:** Aug. 25, 1905, 1♂, Hart. **Parker:** May 18, 1908, 1♂, Hart.

N. cristatus compressus Morse.—This race is close to typical *cristatus* and individual males are often very difficult to distinguish. The few specimens of this sex before us from southern Illinois listed as the latter may therefore be shown by series from that region to be better considered intergrades or even representatives of the present more southern race. Eight specimens from Vigo county, Ind. in the author's collection are intermediate. To the east the present race apparently occurs further north as we have a typical female from Muncie, Ind. and a typical male from Cleveland, Ohio.

Though we have no material from southern Illinois which we can refer definitely to *cristatus compressus*, we have strong evidence to indicate that intergradation with typical *cristatus* will be found in the northern section of that region and that extreme southern Illinois is probably populated by typical *cristatus compressus*.

N. cristatus denticulatus Morse.—Additional material now before us from Oklahoma and the specimens here recorded lead us to believe that this insect had best be recognized as a southwestern geographic race, though poorly defined, and not a synonym of *cristatus arcuatus* showing a decided tendency toward *cristatus compressus*, as we have previously thought. The majority of the races of *cristatus*, though apparently worthy of recognition, are separated on no more distinctive features than the present.

In *cristatus denticulatus* the pronotal surface is decidedly tuberculate, the fastigium much as in *cristatus cristatus*, the pronotal cristation and compression more pronounced than in that race and nearly as decided as in *cristatus compressus*.

The sole Illinois record is **Homer**: Oct. 7, 1906, 3♀, 1 caudate.

This is a limital record, far northeast of the point to which we had expected to find *cristatus denticulatus*. Though recorded from localities to the south and west, the series of *cristatus cristatus* here recorded from Illinois shows no variation whatever toward *cristatus denticulatus* and the presence of the latter at Homer apparently can only be explained by the probability that in Illinois it is limited to local areas of different environment.

Acridium Geoffroy

KEY TO SPECIES

1. Fastigium triangularly produced, with median carina not or scarcely projecting, fig. 22. Antennal joints comparatively stout and caudal femora slender.
.....**granulatum**, p. 168
Fastigium with sides convex and median carina projecting. Antennal joints comparatively slender and caudal femora stout⁵.....2
2. Fastigium projecting well beyond the eyes, fig. 21, with sides convex. Lateral carinae of cephalic portion of pronotum typically parallel.....3
Fastigium projecting little beyond eyes, nearly truncate. Lateral carinae of cephalic portion of pronotum typically slightly convergent caudad..
.....**arenosum angustum**, p. 169
3. Form more robust. Pronotum often showing a trace of tectation. Fastigium often showing very weak indication of triangular production.....
.....**acadicum acadicum**, p. 169
Form less robust. Pronotum showing no trace of tectation. Fastigium normally showing less production.....**ornatum**, p. 169

A. granulatum Kirby.—The species is found only in northern Illinois, Homer and Bloomington being points on its southern limit of distribution.

Three specimens from Chicago and one from Algonquin are subcaudate, the others are fully caudate.

⁵The three species of *Acridium* which follow are extremely variable and a key is not to be relied upon.

Beach: Aug. 21, 1906, 1♀ with pale mediolongitudinal dorsal band and broad dark margins opposite shoulders, in swamp, Hart. **Chicago:** Apr. 28, 1906, 3♂, 1♀, 1 pair with pale mediolongitudinal dorsal band, on beach of Lake Michigan. **Lake Villa:** Aug. 10, 1906, 1♂, 1♀, in swamp, Hart. **Algonquin:** Apr. 14, 1895 to Oct. 9, 1905 and 1908, 4♂, 3♀, 1♀ with striking buff mediolongitudinal dorsal band. **Bloomington:** Nov. 3, 1883, 1♀ with lateral margins of pronotum narrowly pale. **Homer:** May 16, 1906, 2♂, 1 with pale mediolongitudinal dorsal band, Hart. **Urbana:** Mar. 24 to Sept. 9, 1889 to 1905, 7♂, 3♀.

A. acadicum acadicum (Scudder).—This is probably a rarer tettigid but of local occurrence over all of Illinois.

Peoria: Sept. 9, 1905, 1♀. **Homer:** June 10, 1926, 1♀, Frison. **Urbana:** Sept. 9, 1898, 1♂, Woodworth; Sept. 13 and 14, 1909, 2♀. **Champaign:** May 8, 1886, 1♀, Forbes and Weed. **Mahomet:** Apr. 23, 1925, 1♀, Frison. **Carbondale:** Apr. 23, 1925, 1♂, Chandler. **Elizabethtown:** Aug. 8, 1905, 1♀. **Karnak:** Sept. 2, 1924, 1♀, Frison.



Fig. 155.—Adult male of the pygmy locust *Acridium ornatum* (Say). $\times 9$.

A. ornatum (Say).—In the vicinity of Chicago the insect usually shows extreme depauperation, but some of the specimens from Muncie, Homer, Urbana, Quincy, Dubois and Pulaski are unusually large and robust with mediolongitudinal carina of pronotum slightly more decided than usual and are consequently difficult to separate from small individuals of *acadicum acadicum*. This common species was correctly recorded by Thomas (1876) and McNeill (1891), but by the latter in addition as the synonym *triangularis*.

The insect is to be found over all Illinois. Seventy-five males, 90 females and nine immature specimens were taken at **Beach, Waukegan, Summit, Chicago, Pullman, Deep Lake, Algonquin, Elizabeth, Fulton, Bradford, Ashkum, Kappa, Loda, Paxton, Ludlow, Rantoul, Normal, Bloomington, Havana, Danville, Hilliary, Georgetown, Muncie, Oakwood, Homer, Ogden, Thomasboro, Urbana, Champaign, Seymour, White Heath, Lincoln, Conover, Tolono, Quincy, Galton, Snyder, Litchfield, Mt. Carmel, Dubois, Carbondale, Grand Tower, Pulaski**, from March 30 to November 3.

A. arenosum angustum (Hancock).—In material from central Illinois frequent specimens show a slight tendency toward *arenosum*

arenosum and in southern Illinois this is more often seen and more pronounced. All of Illinois is included in the distribution of *arenosum angustum*. This race is weakly defined and in this state subject to marked individual variation.

One hundred and twenty-five males, 109 females and three immature individuals are from Algonquin, Savanna, Galesburg, Havana, Quiver Lake, Bryant, Muncie, Oakwood, Homer, Urbana, Mahomet, White Heath, Woodyard, Paris, Pike, Marshall, Hardin, Lawrenceville, Mt. Carmel, Carmi, Dubois, Carbondale, Grand Tower, Herod, Alto Pass, Cobden, Anna, Jonesboro, Aldridge, Metropolis, Vienna, Karnak, Dongola, Pulaski, Villa Ridge.

Neotettix Hancock

KEY TO SPECIES

So variable are the species of the genus *Neotettix* treated here that a key is not to be relied upon.

Pronotum with dorsal surface finely granulose. Caudal femora with ridges not prominent..... **femoratus**

Pronotum with dorsal surface rugosotuberculate. Caudal femora with ridges prominent..... **bolteri**

N. femoratus (Scudder).—This is the first record for Illinois and a northern limit point, others being Crawford county in central southern Indiana, and Olden in central southern Missouri, for which the material is in the author's collection.

Elizabethtown: May 27 to 31, 1932, 1♂, 3♀, Dozier. **Pulaski:** May 25, 1932, 1♀, Dozier.

N. bolteri Hancock.—These specimens are robust and have the pronotum abbreviate. The caudal apex of the pronotum shows much individual variation, as follows: acute in two females, nearly acute but narrowly rounded in nine males and three females, broadly rounded truncate in one male and one female, and broadly bilobate in one female.

Dubois: July 3, 1909, 1♂. **Wolf Lake:** May 5, 1932, 1♂, Dozier. **Pulaski:** May 19 to June 10, 1907 and 1908, 9♂, 7♀.

These are northern limit records and Wolf Lake is a westernmost point as well.

Paratettix Bolivar

P. cucullatus (Burmeister).—Northern limit points are Algonquin and Savanna, the species occurring over all but the extreme northern margin of the state.

Forty-nine males, 46 females and 54 immature individuals were taken at Algonquin, Chana, Savanna, Moline, Galesburg, Normal, Havana, Quiver Lake, Muncie, Oakwood, Homer, St. Joseph, Urbana, Champaign,

Mahomet, White Heath, Matanzas Lake, Quincy, Pike, Hardin, Grafton, Lawrenceville, Centralia, Mt. Carmel, Carmi, Du Quoin, Shawneetown, Carbondale, Running Lake, Fountain Bluff, Grand Tower, Herod, Elizabethtown, Golconda, Metropolis, Pulaski, Villa Ridge, Thebes. The adults, all of which have the pronotum caudate, were secured between May 7 and October 13.

Tettigidea Scudder

KEY TO SPECIES

1. Disk of pronotum with cephalic margin convex: dorsal surface very finely granulate, appearing almost smooth, with few very weak rugae and median carina weak.....2
 Disk of pronotum with cephalic margin produced either in a large cusp or a sharp angle; dorsal surface longitudinally strongly rugose, the median and lateral carinae well developed.....*acuta*, p. 172
2. More robust. Northern race, if valid.....*lateralis parvipennis*, p. 171
 More slender. Southern race, if valid.....*lateralis lateralis*, p. 171

T. *lateralis parvipennis* (Harris).—The validity of this form has already been noted by us (Hebard 1932) as open to serious question. The intergradation which occurs with typical *lateralis* cannot be plotted in Illinois with any regularity. A series before us from the beach at Lincoln Park, Chicago, averages distinctly more slender than that from Urbana, while the male from Odin and five females from Pulaski are robust. These facts are not as would be expected, typical *lateralis* being supposedly a more slender southern race.

Under *lateralis parvipennis* we have here listed all but material we consider typical of *lateralis lateralis*. The insect was recorded as *lateralis* and abbreviate material as the synonym *polymorpha* by both Thomas (1876) and McNeill (1891).

One hundred and forty-one males and 162 females were taken from March 4 to October 7, and 28 immature specimens are also before us. They were secured at Beach, Chicago, Pullman, Edgewater, Channel Lake, Cedar Lake, Lake Villa, Deep Lake, Wauconda, Algonquin, Savanna, Summit, Bradford, Normal, Bloomington, Funks Grove, Havana, Cuba, Danville, Hilliary, Muncie, Oakwood, Homer, St. Joseph, Urbana, Champaign, Mahomet, Seymour, White Heath, Woodyard, Quincy, St. Francisville, Odin, Mt. Carmel, Dubois, Grand Tower, Herod, Cobden, Aldridge, Metropolis, Vienna, Pulaski. The series is about evenly divided between the caudate and abbreviate phases.

T. *lateralis lateralis* (Burmeister).—The typical form of this species is only scantily represented in the collections from Illinois, whereas what is considered as *parvipennis* is abundant.

Chicago: Sept. and Nov. 1909, 2 ♂, 3 ♀. **Wauconda:** July 6, 1932, 1 ♂. **Savanna:** Sept. 11, 1932, 1 ♀, Frison and Mohr. **Urbana:** June 5, 1885, 1 ♀. **Mahomet:** Sept. 12, 1932, 2 ♀, Park. **White Heath:** Nov. 25, 1927, 1 ♀.

Lawrenceville: Sept. 24, 1932, 1♀, Frison and Mohr. **East St. Louis:** July 18, 1906, 1♂, 1♀, female caudate. **Herod:** Sept. 4, 1932, 1♀, Ross and Horsfall. **Anna:** June 8 to 28, 1907 to 1913, 3♂, 1♀, all caudate; Sept. 6, 1884, 8 juv. **Golconda:** Aug. 3, 1932, 1♀, Dozier.

T. acuta Morse.

- 1895 *Tettigidea acuta* Morse, Jour. N. Y. Ent. Soc., vol. 3, p. 15; vol. 4, pl. II, fig. 7. ♀, New York.
 1895 *Tettigidea apiculata* Morse, *ibid.*, vol. 3, p. 16; vol. 4, pl. II, figs. 8 and 8a. ♂, ♀, New Orleans, La.
 1895 *Tettigidea armata* Morse, *ibid.*, vol. 3, p. 107; vol. 4, pl. II, figs. 10 and 10a. ♀, Vigo county, Ind.; Dallas, Tex.
 1895 *Tettigidea armata depressa* Morse, *ibid.*, vol. 3, p. 107. ♂, Jacksonville, Fla.; ♀, Vigo county, Ind.; St. Johns river and Fort Reed, Fla.; New Orleans, La.
 1895 *Tettigidea spicata* Morse, *ibid.*, vol. 3, p. 108; vol. 4, pl. II, figs. 9 and 9a. ♂, Georgia; ♀, Florida.
 1908 *Tettigidea davisi* Morse, Psyche, vol. 15, p. 25. ♂, ♀, Perth Amboy and Jamesburg, N. J.; Staten Island, N. Y.

Rehn and Hebard (1916b) placed *armata depressa* and *davisi* as synonyms of *armata*. In considering the above names we now find that only a single species is represented. This species, like many others of the Acrydiinae, develops both a caudate and an abbreviate pronotal form. In the present case the abbreviate condition has the median carina of the pronotum more prominent with the dorsum usually showing slight but distinct concavity on each side. Such also appears more rarely in caudate individuals and specimens showing these features were described and have until now been recognized generally as *armata*. In the caudate condition, however, the pronotal disk is usually slightly to decidedly convex, the median carina becoming weaker as such convexity increases. Such individuals we have previously recorded as *spicata*, realizing that *apiculata* was very similar. In 1920 Blatchley, seeing the very decided affinity to *armata*, placed *spicata* as a race and further stated that *apiculata* might represent merely an intergrade and being the oldest name of the three would take specific status for the entity if such were proven.

We have been able to examine the types of all the names given above and a very large series has now been arranged in geographic sequence in our collections. It is surprising to find that *acuta* is the oldest name available for the species in question, based on caudate females with pronotal dorsum convex and showing a very faint mediolongitudinal carina and unusual smoothness. Compared with them the types of *apiculata* and *spicata* are inseparable except for the greater roughness of the dorsum and more spicate cephalic margin of the pronotum. Both these features are shown by our series to be matters of mere individual

variation. Moreover the greater or less convexity and degree of development of the median carina of the pronotum in caudate individuals is just as conclusively proven by the series to have no greater diagnostic weight.

It is true that in the south material from salt marshes is usually caudate with spiculation decided and dorsum convex with weak median carina, but on the Mullica river flats in New Jersey a very large series secured by us includes similar material only, while a series from Sea Isle Junction, N. J. has 11 males and five females abbreviate with pronotum concave laterad of the decided median carina, but four females are caudate and in all other respects as in the Mullica river material. Finally, on the bare soil in swamps from the great lakes to the gulf, the normal is the "*armata*" type, but quite frequently individuals are indistinguishable from the "*apiculata*" condition. Thus even racial recognition can evidently not be given any of the five names here placed in synonymy.

Northern limits are shown by material in the author's collection to be Staten Island, N. Y., Sandusky, Ohio and Dune Park, Ind. Though Urbana, Ill. is a northwestern limital point, the species in the southwest reaches Howe, Okla. and Dallas, Tex., so that it will probably be found locally on bare soil in swamps over all but extreme northern Illinois.

Urbana: Nov. 6, 1907, 1♂, caudate. **Dixon Springs:** Oct. 13, 1932, 1♂, caudate, Frison and Ross.

ACRIDINAE

Pseudopomala Morse

P. brachyptera (Scudder).—This scarce and handsome species is probably present but very local in the northern portions of the state. These records are limital southward and the first for Illinois.

Bishop: Aug. 13, 1907, 1♂, 1♀. **Devil's Hole:** June 29, 1910, 1♂; Aug. 15, 1907, 2♀. **Urbana:** Aug. 13, 1885, 1♀ in bluegrass and timothy. **Champaign:** Aug. 1879, 2♀, *TC*. **Charleston:** Aug. 8, 1910, 1♂ in tall grass.

Truxalis Fabricius

T. brevicornis (Linnaeus).—Havana, Muncie and Champaign are northern limital records. Southward the species occurs probably throughout the marshes and swamps in the state.

Havana: Aug. 11 to 23, 1907 and 1910, 8♂, 7♀, 2♀ brown, 3♀ green, 1♀ green with brown dorsum, river shore, swamp. **Muncie:** July 24, 1932, 1♂, Park. **Champaign:** July 30, 1885, 1♂ at light, Hart; July 31, 1886, 1♂, 1♀, female green, Hart; Aug. 25, 1885, 1♀, brown, at light, Hart. **Billett:** Sept. 7, 1933, 7♂, 2♀, 1 pair brown, 1♀ green, Ross and Mohr. **Aldridge:** Aug. 11, 1891, 5♂, 1♀, female brown, Mississippi river bottom, Hart and Shiga.

Mermiria Stal

KEY TO SPECIES

1. Pronotum elongate, with distinct lateral carinae. Caudal legs elongate and slender. Form more slender. Lateral foveolae weakly indicated. *neomexicana*
 Pronotum short, lacking lateral carinae. Caudal legs relatively robust. Form less slender. 2
2. Male lacking a subcostal pale bar on proximal half of tegmina. Fastigiofacial angle averaging broader. Coloration more frequently greenish. *bivittata*
 Male with a subcostal pale bar on proximal half of tegmina. Fastigiofacial angle averaging narrower. Coloration more frequently buffy. *maculipennis macclungi*

M. neomexicana (Thomas).—These are easternmost records and Forest City a northernmost as well for this western species. In Illinois it is probably very local, occurring only in sandy areas and on waste land.

Forest City: Aug. 20, 1904, 1 ♂ in sand dunes with blackjack oak, Hart and Brown. **Bishop:** Aug. 13, 1907, 5 ♂. **Devil's Hole:** Aug. 13 to Sept. 11, 1904 to 1912, 23 ♂, 19 ♀, 1 large juv. ♀, 13 ♀ brown, 1 ♀ green but tegmina wholly brown, 6 ♀ green.

M. bivittata (Serville).—These are northern limits for this scarcer species, which was recorded from Illinois with uncertainty by Thomas in 1880, the present specimens by Hart in 1907.

Chautauqua: Aug. 20, 1906, 1 ♂ on bluff. **Tamaroa:** Sept. 22, 1882, 1 ♀, TC.

M. maculipennis macclungi Rehn.—These are eastern limits for this western species, Fulton being also northernmost and Meredosia southernmost in this longitude. The insect is probably very local in Illinois, occurring only in sandy areas and on waste land. It was reported from the vicinity of Havana incorrectly as *bivittata* (in part) by Hart in 1907, by Vestal in 1913 and correctly by Rehn in his revision of the genus in 1919.

Fulton: July 20, 1927, 4 ♂, 6 ♀, 2 large juv. ♀. **Forest City:** Aug. 20, 1904, 2 ♂, 2 ♀, sand dunes with blackjack oak, Hart and Brown. **Devil's Hole:** Aug. 7 to Sept. 2, 1903 to 1912, 5 ♂, 6 ♀, sand dunes. **Devil's Neck:** Aug. 22, 1904, 1 ♂ on sand prairie, Hart and Brown. **Meredosia:** Aug. 23 to 30, 1905 to 1917, 3 ♂, 2 ♀, in sand pit.

Syrbula Stal

S. admirabilis (Uhler).—The distribution of this graceful species covers practically all Illinois.

Kenilworth: July 8, 1899, 2 ♀, green, Hancock. **Chicago:** Aug. 26 to Sept. 7, 1901, 8 ♂, 7 ♀, 5 ♀ green, 8 ♂ and 2 ♀ brown. **Algonquin:** Sept. 23, 1905,

1♀, green, Nason. **Dixon**: 1♀, Ross. **Amboy**: Aug. 25, 1933, 1♀, Ross and Mohr. **Fulton**: July 20, 1927, 1♂, 2♀, females green. **St. Anne**: Aug. 28, 1932, 6♂, 8♀, 6♀ green, 6♂ and 2♀ brown, Ross and Mohr. **Bartonville**: Aug. 29, 1910, 1 medium juv.♀ on bluffs. **Peoria**: Sept. 9, 1905, 1♀, very small, green. **Forest City**: Aug. 20, 1904, 1♀, Hart and Brown. **Devil's Hole**: Aug. 17 to 26, 1903 to 1910, 2♂, 2♀, 2 juv.♀, 1♀ green, 1♀ brown, river shore in sand region. **Homer**: Aug. 29 and Oct. 7, 1906, 3♀, green. **Urbana**: Sept. 20, 1906, 4♀, green. **Teheran**: Aug. 7, 1904, 1 large juv.♀, 1 small juv.♀, Hart and Brown. **Bath**: Aug. 17, 1903, 1♂ in sandy blackjack oak area, Hart. **Meredosia**: Aug. 22, 1917, 2♂ in sand pit. **Quincy**: Oct. 6, 1903, 1♀, green, Taylor and Hart. **Nokomis**: Sept. 7, 1932, 1♂, Ross and Mohr. **Hillsboro**: Sept. 7, 1932, 8♀, Ross and Mohr. **Alton**: Sept. 6, 1932, 1♂, 3♀, females green, Ross and Mohr. **Lawrenceville**: Sept. 24, 1932, 3♀, Frison and Mohr. **Clay City**: Sept. 2, 1909, 1♀, brown. **Alma**: Oct. 12, 1932, 2♀, Frison and Ross. **Dubois**: Aug. 9, 1917, 1♂, 1 small juv.♂. **Shawneetown**: Oct. 12, 1932, 1♀, Frison and Ross. **Grand Tower**: June 25 to July 25, 1905, 1 large juv.♂, 1 medium juv.♀; July 24, 1905, 1♂; Aug. 5, 1905, 2♂. **Alto Pass**: Aug. 27, 1899, 1♂, Hart. **Golconda**: Oct. 13, 1932, 3♀, Frison and Ross. **Dixon Springs**: Sept. 5, 1932, 9♀, Ross and Horsfall. **Metropolis**: Aug. 17, 1891, 1♂; Aug. 19, 1891, 1♂, foot of low bluffs, Hart and Shiga; Sept. 3, 1924, 1♂, Frison.

Amphitornus McNeill

A. coloradus (Thomas).—In the present series supplementary pronotal carinae are lacking in two males and one female.

This is a western species, widespread on the plains and it is interesting to find it so far east on the prairies of Illinois, where it is probably very local. The following localities are limital eastward, Forest City being also a northernmost point and the nearby Havana a southernmost point for the species in this longitude. Hart first recorded it from Illinois in 1907 as the homonym *bicolor*.

Forest City: Aug. 20, 1904, 2♀ among blackjack oak in sand dunes, Hart and Brown. **Bishop**: Aug. 13, 1907, 5♂, 5♀. **Devil's Neck**: Aug. 22, 1904, 3♀, 1 juv.♀, sand prairie, Hart and Brown. **Havana**: Aug. 7, 1908, 1♀.

Eritettix Bruner

E. simplex (Scudder).—The present species probably occurs over all Illinois, but is probably local and confined to areas of comparatively poor soil. It was recorded as the synonym *virgatus* from Havana by Hart in 1907. Two adult females from Havana and the Topeka immature specimen alone have the dorsum of the pronotum wholly pale and uniform in color.

This series is typical of *simplex*; no tendency whatever toward the western *tricarinatus* (Thomas) is shown.

Forest City: June 6, 1905, 1♀. **Topeka**: Oct. 30, 1907, 1 medium juv.♀. **Devil's Hole**: Apr. 27 to June 29, 1910 and 1912, 9♂, 10♀, 2 large juv.♀, majority of adults and the 2 juv. taken earliest date.

Orphulella Giglio-Tos

KEY TO SPECIES

Pronotum with lateral carinae little incurved, about equally separated cephalad and caudad, particularly the female, fig. 39. Vertex blunt, its central depression extending close to the apex. Prozona longer than metazona. Form usually less graceful and organs of flight less caudate.....**speciosa**

Pronotum with lateral carinae strongly incurved with angulation often indicated, the distance between them considerably greater caudad than cephalad, fig. 38. Vertex rectangular or in male a little acute, its central depression removed from apex one-third (male) to one-fourth (female) the width of the vertex. Prozona and metazona about equal in length. Form usually more graceful and organs of flight more caudate.....**pelidna**

O. pelidna (Burmeister).—All of Illinois is included in the distribution of this species, which when found is usually present in considerable numbers.

The females taken in Illinois have the dorsum as follows: eight specimens dark to light brown, seven green but one of these with dorsal portions of tegmina deep purplish vinaceous.

This species and *speciosa* were confused by Thomas (1876) and McNeill (1891) and recorded as *maculipennis*, a synonym of *pelidna*.

Beach: Aug. 21 to 26, 1906 and 1932, 13♂, 12♀. **Waukegan:** Aug. 16 to 25, 1906 to 1917, 7♂, 5♀, in swamps and on beach. **Chicago:** Aug. 30 and Sept. 7, 1901, 4♂, 3♀. **Meredosia:** Aug. 22 to 30, 1905 and 1917, 3♀.

O. speciosa (Scudder).—This common species is generally distributed in grassland throughout Illinois.

Beach: Aug. 24, 1932, 1♀, Ross and Mohr. **Waukegan:** Aug. 16, 1906, 1♀ in swamp. **Kenilworth:** July 18 and Aug. 24, 1899, 5♀. **Winnetka:** Aug. 22, 1897 and Sept. 11, 1899, 8♂, 4♀. **Chicago:** Aug. 15 to Sept. 7, 1901, 3♂, 5♀. **Channel Lake:** Aug. 14, 1906, 1♀ in sand hills. **Deep Lake:** Aug. 2 and 8, 1906, 3♂, 5♀. **Algonquin:** July 20 to Aug. 19, 1905, 6♂, 11♀, 1 large juv.♀. **Downers Grove:** Aug. 13, 1902 and Aug. 19, 1901, 3♂, 4♀. **Starved Rock:** July 14, 1932, 2♂, Dozier and Park. **Colona:** Aug. 16, 1♂, 1♀. **Green River:** Aug. 14, 1♂. **Moline:** Sept. 9, 1905, 4♂, 6♀, in sand hills. **St. Anne:** Aug. 28, 1932, 4♂, 5♀, Ross and Mohr. **Peoria:** Sept. 9, 1905, 1♂. **Elliott:** Aug. 10, 1906, 1♂. **Forest City:** Aug. 20, 1904, 1♂ in sand dunes with blackjack oak, Hart and Brown. **Bishop:** Aug. 13, 1907, 3♀. **Urbana:** July 24, 1891, 1♂ at light, Hart and Shiga. **Taylorville:** Aug. 11, 1902, 2♀, Titus. **Bluffs:** Aug. 19, 1917, 2♂. **Chautauqua:** July 20, 1906, 2♀ on bluff. **Alton:** Sept. 8, 1932, 5♂, Ross and Mohr. **Clay City:** Aug. 21, 1905, 3♂, 1♀. **Odin:** Aug. 28, 1909, 1♀. **Browns:** Aug. 21, 1902, 1♀ in grass in orchard, Titus. **Dubois:** Aug. 24, 1905, 1♀. **Murphysboro:** July 22, 1905, 1♀. **Fountain Bluff:** July 25, 1905, 3♀.

Dichromorpha Morse

D. viridis (Scudder).—This is a common species generally distributed over Illinois.

A single brown female taken at Grand Tower on August 5, 1909, is almost fully macropterous. This is a very rare occurrence in the species; there are four such in the author's collection—one green female from Minersville, Pa., two green females from Jacksonville, Fla. and one brown male from Canton, S.D.

Forty-one males, 41 females and three immature individuals represent the following localities: Savanna, Geneseo, Port Byron, Bartonville, Bloomington, Topeka, Havana, Muncie, Homer, Urbana, Athens, Charleston, Jacksonville, Bluffs, Florence, Neoga, Grafton, Alton, Lawrenceville, Mt. Carmel, Chester, Shawneetown, Carbondale, Grand Tower, Herod, Cobden, Aldridge, Golconda, Metropolis, Whitehill, Cache, Cairo. The adults were taken between June 28 and October 17. Seventeen males, 25 females and two immatures are brown, the others green.

Chloealtis Harris

C. conspersa Harris.—Arenzville and Mt. Carmel are southernmost points, the species becoming probably less and less numerous and more local south to those localities.

Beach: Aug. 24 to 26, 1932, 4♂, 1♀, Ross and Mohr. **Antioch:** Aug. 1, 1924, 1♂ in tamarack bog. Frison. **Channel Lake:** Aug. 13, 1906, 1♀ in woods. **Deep Lake:** Aug. 8, 1906, 7♂, 8♀. **Algonquin:** July 21, 1905, 1♂, Nason; July 31, 1905, 1♂, Nason. **Savanna:** Sept. 6, 1905, 1♀. **Moline:** July 21, 1♂, McNeill. **Forest City:** Aug. 20, 1904, 1♂, 2♀, sand dunes with blackjack oak, Hart and Brown. **Havana:** July 1910, 2♂, 3♀. **Muncie:** June 15, 1906, 2 medium large juv.♀; Sept. 18 and 22, 1905 and 1906, 1♂, 2♀. **Homer:** July 20, 1907, 2♂. **Urbana:** July 5, 1889, 1♂; July 6, 1889, 1♂; July 13, and 19, 1889, 3 medium large and large juv.♀ in pond grove. **Champaign:** June 5, 1889, 1 medium juv.♂. **White Heath:** June 18, 1906, 1♀ in woods. **Bath:** Aug. 14, 1903, 1♂ in sand region with weeds and blackjack oak, Hart. **Arenzville:** Aug. 14, 1913, 1♂ on sandy bluff. **Charleston:** Aug. 16, 1910, 1♂, 1♀, in forest. **Mt. Carmel:** July 2, 1906, 1♂.

Chorthippus Fieber

C. curtipennis (Harris).—Algonquin and Urbana are southern known limits of this common species of lush grasses, swamps and bogs. It is apparently very abundant in such environments in northeastern Illinois.

Beach: July to Aug. 28, 1906, 1926 and 1932, 9♂, 25♀, 1♀ macropterous. **Zion:** July 6, 1932, 8♂, 2♀. **Waukegan:** Aug. 18 and 20, 1906, 2♂, 3♀, in swamps. **Chicago:** July 17 to Oct. 9, 1909, 7♂, 6♀, Allen. **Antioch:** July 5, 1932, 1♂, Frison; Aug. 27, 1932, 1♂, 1♀, Ross and Mohr. **Channel Lake:** Aug. 13 and 14, 1906, 2♂, 4♀, in swamp and woods. **Lake Villa:** Aug. 9 and 10, 1906, 4♂, 9♀, 2 juv. **Sun Lake:** Aug. 3, 1906, 3♂, 1♀, in



Fig. 156.—A short winged grasshopper, *Dichromorpha viridis* (Scudder), ♀. × 2.4.

bog. **Cedar Lake:** Aug. 4 and 7, 1906, 2♂, 2♀, in bog and among tamaracks. **Deep Lake:** Aug. 2 and 8, 1906, 4♂, 3♀, 1 juv. **Algonquin:** July 6 to Sept. 22, 1905 and 1907, 36♂, 28♀, 3 juv. **Urbana:** Sept. 30, 1901, 2♂, 3♀, Titus. **Champaign:** Aug. 31 to Sept. 5, 1885, 2♂.

Stethophyma Fischer

KEY TO SPECIES

Pronotum with lateral carinae parallel. Sternite preceding male subgenital plate with a black mediolongitudinal line. Pronotum with prozona and metazona equal in length. Tegmina lacking a pale stripe **platyptera**

Pronotum with lateral carinae divergent caudad. Sternite preceding male subgenital plate immaculate. Pronotum with prozona shorter than metazona. Tegmina with a pale stripe proximad near costal margin **lineatum**

S. platyptera (Scudder).—The present records define the southern known limits for this swamp loving species in this longitude. Long considered an exceedingly rare insect, it is now becoming evident that it not only has a much wider distribution than was supposed, but that though very local it may sometimes be found in large numbers. It is however safe to say that *platyptera* is not only one of the handsomest, but also one of the least frequently encountered boreal North American grasshoppers. These specimens were recorded by Hart (1907).

Champaign: July 31, 1904, 1♀, Hart. **Teheran:** June 22, 1♂, Hart.

S. lineatum (Scudder).—This large and handsome insect inhabits a similar environment, is much more frequently encountered and is decidedly more numerous than *platyptera*. Matanzas Lake is the southern limit point.

It was probably this insect which Thomas reported from extreme northern Illinois, with a query, as *gracile* in 1876 and for which McNeill recorded a specimen from Iowa opposite Watertown, Ill. in 1891. Part of the present material was recorded by Hart in 1907.

Waukegan: July 6, 1932, 1♂, Frison. **Antioch:** Aug. 17, 1932, 17♂, 3♀, Ross and Mohr. **Sun Lake:** Aug. 3, 1906, 1♀ in bog. **Matanzas Lake:** July 6, 1898, 1♂, Hart.

Ageneotettix McNeill

A. deorum (Scudder).—This very common sand loving species was reported by McNeill incorrectly as *Phlibostroma parva?* (= *quadrimaculatum*) in 1891 and as the synonym *scudderi* in 1897. It was again so reported by Hart in 1907 and correctly by Vestal in 1913.

Very widespread in the west, southeastern limits are Meredosia, Ill. and Vigo county, Ind.

Beach: Aug. 21 to 27, 1906 and 1925, 12♂, 15♀. **Zion:** Aug. 25, 1932, 2♂, 10♀, Ross and Mohr. **Waukegan:** Aug. 25, 1917, 1♂. **Oregon:** July 4, 1932, 1♂, Dozier and Mohr. **Fulton:** July 20, 1927, 5♂, 12♀. **Starved Rock:**

July 14, 1932, 15♂, 18♀, Dozier and Park. **Moline**: Aug. 29, 1♀, McNeill; Sept. 9, 1905, 1♂ on sand hill. **St. Anne**: Aug. 28, 1932, 6♂, 11♀, Ross and Mohr. **Forest City**: June 5, 1905, 1 juv. **Manito**: Aug. 31, 1910, 3♂, 3♀. **Bishop**: Aug. 13, 1907, 1♀. **Devil's Hole**: Aug. 12 to Sept. 2, 1903 to 1907, 12♂, 11♀. **Devil's Neck**: July 7, 1905, 1 juv.; Aug. 22, 1904, 1♀ in sand prairie, Hart and Brown. **Havana**: Aug. 25, 1933, 2♂, Ross and Mohr; Oct. 29, 1907, 2♀. **White Heath**: July 22, 1925, 1♂, Frison. **Meredosia**: Aug. 17 to 30, 1905 to 1917, 2♂, 3♀.

OEDIPODINAE

Arphia Stal

KEY TO SPECIES

1. Pronotum with median carina very high, arched, strongly cristate, fig. 48. Taenia of broad wing band short. Size larger. Appears adult in summer. Caudal tibiae usually black to the proximal annulus. Wing disk individually varying from yellow through orange to pink. **xanthoptera**, p. 180
Pronotum with median carina much lower, very feebly arched, fig. 47. Taenia of wing band elongate. Smaller. 2
2. Impressed area of fastigium as broad as (male) or broader than (female) long, its sides straight convergent to the acute apex, particularly in male, fig. 50. Vertex joining frontal costa with a definite angulation indicated in the convexity. Appears adult in spring. Wing disk always yellow. Caudal tibiae with mesodistal portion of dark section often briefly glaucous or buffy. **sulphurea**, p. 179
Impressed area of fastigium longer than broad, its sides slightly arcuate convergent to its truncate apex, fig. 51. Vertex joining frontal costa in an even convexity. Appears adult in summer. Wing disk rich pink, rarely buff yellow in northeastern portion of its distribution only. Caudal tibiae usually black to proximal annulus. **pseudonietana**, p. 180

A. sulphurea (Fabricius).—In this series the caudal tibiae beyond the broad pale proximal annulus are almost black, sometimes slightly paler and bluish in median portion laterad and ventrad. Only in two females (Oakwood, Parker) is that entire area bluish white. The tegmina are uniform brown in the great majority, five males showing a slightly paler dorsal band but two males having this band very pale and conspicuous.

Beach: July 16, 1928, 1♀, Frison and Hayes. **Chicago**: June 6 to 15, 1903 to 1905, 6♂, 3♀. **Cedar Lake**: June 19, 1892, 1♂, Hart and Shiga. **Mt. Carroll**: June 15, 1932, 2♂, 2♀, Frison and Mohr. **Willow Springs**: May 23, 1922, 2♂, Gerhard, *FM*. **Moline**: June 5, 1♂, McNeill. **Rock Island**: June 3, 1930, 1♂, Frison and Ross. **Galesburg**: Apr. 1889, 1♂, *HIC*. **Prospect**: June 29, 1906, 1♂. **Forest City**: June 6, 1905, 1♂. **Bishop**: June 23, 1906, 1♂, 2♀. **Havana**: June 23, 1926, 2♂, Frison and Hayes. **Muncie**: June 14 to 30, 1907, 2♂, 4♀; Sept. 22, 1906, 1 juv. ♂ with occiput and disk of pronotum gray with black flecks. **Vermilion county**: May 30, 1926, 1♂, 2♀, Auden. **Oakwood**: May 18 to June 18, 1927, 13♂, 7♀. **Homer**: May 14 to June 21, 1906 and 1926, 4♂, 3♀, 1♀ with occiput and disk of pronotum greenish gray with minute dark flecks. **Urbana**: June 3 to

July 29, 1889 to 1891, 3♂, 3♀. **White Heath**: June 20, 1906, 1♀ in woods. **Odin**: June 25, 1909, 1♂. **Dubois**: June 22, 1905, 1♂. **Carbondale**: June 7, 1907, 1♂, 1♀ with occiput and disk of pronotum gray with black flecks. **Grand Tower**: June 27, 1906, 3♂. **Parker**: June 12, 1907, 1♀. **Cobden**: May 7, 1918, 1♂. **Pulaski**: June 10, 1907, 2♂, 1♀, on bluff.

A. xanthoptera (Burmeister).—Recorded as the synonym *carinata* by Thomas (1876), McNeill included that name in his 1891 list.

Chicago: Aug. 15 to Sept. 28, 7♂, 3♀, wing disk yellow in 2♀, yellow with a faint orange tinge in 4♂, orange in 1♂ and 1♀, grenadine in 1♂, strawberry pink in 1♂. **Dixon**: 2♂, wing disk yellow in 1, rich orange in 1, Ross. **Starved Rock**: July 14, 1932, 4♂, 3♀, Dozier and Park. **St. Anne**: Aug. 28, 1932, 1♂, 1♀, Ross and Mohr. **Forest City**: Aug. 20, 1904, 2♀, wing disk orange in 1, grenadine in 1, Hart and Brown. **Devil's Hole**: Aug. 15, 1907, 1♀ with wing disk yellow with a faint orange tinge. **Hamilton**: Aug. 30, 1931, 1♂ with wing disk orange, Ross and Mohr. **Urbana**: Aug. 30, 1891, 1♂ with wing disk grenadine, Hart; Oct. 18, 1889, 1♀ with wing disk yellow with a faint orange tinge, Marten. **Champaign**: Aug. 4, 1911, 1♀ with wing disk yellow, Frison. **Bluffs**: Aug. 19, 1917, 1♂ with wing disk rich orange. **Nokomis**: Sept. 7, 1932, 1♂, Ross and Mohr. **Hillsboro**: Sept. 7, 1932, 1♂, Ross and Mohr. **Grafton**: Sept. 8, 1932, 3♂, Ross and Mohr. **Clay City**: July 22, 1905, 1♀ with wing disk yellow tinged with orange; July 28, 1906, 1 juv.♂. **Albion**: Sept. 24, 1889, 1♂ with wing disk yellow, Marten. **Dubois**: Aug. 24, 1905, 1 large juv.♀. **Running Lake**: Aug. 15, 1883, 1 juv.♀. **Makanda**: Sept. 25, 1931, 1♂ with wing disk yellow, Barrett. **Fountain Bluff**: Aug. 10, 1891, 1♂ with wing disk yellow, roadside, Hart and Shiga. **Grand Tower**: July 29, 1905, 1♂ with wing disk yellow. **Alto Pass**: Aug. 14, 1891, 1♀ with wing disk yellow, Hart and Shiga. **Golconda**: Oct. 13, 1932, 2♀, Frison and Ross. **Dixon Springs**: Oct. 13, 1932, 2♀, Frison and Ross. **Metropolis**: Aug. 17, 1891, 1♂ with wing disk yellow, Hart; Sept. 3, 1924, 1♂ with wing disk orange, Frison. **Karnak**: Sept. 2, 1924, 1♀ with wing disk yellow, Frison. **Cache**: Oct. 14, 1932, 1♂, Frison and Ross.

A. pseudonietana (Thomas).—Thomas recorded this insect as *Tomonotus tenebrosus* in 1876 and as *Tomonotus nietanus* in 1880 from extreme northwestern Illinois. McNeill did not have it nor have we seen it from this state, but we believe that Thomas had material as noted above. Southern known definite limits are Amherst Junction, Wis. and Harbert, Mich., only a few miles from the Illinois line. It is however certain that the insect will not be found except locally and probably only along the extreme northern border of the state.

It is interesting to note that the wing disk is invariably pink and usually rich in tone for all western material but that we have specimens from Minnesota and Wisconsin in which that area is light orange. This color phase will therefore probably also be found in material from Illinois.

Chortophaga Saussure

C. viridifasciata (DeGeer).—This species is distributed over the entire state.

Seventy-two males and 69 females, taken April 14 to September 6, the great majority in June, and 16 immature individuals were secured at Lake county, Glencoe, Kenilworth, Chicago, Algonquin, Oregon, Sterling, Galena, Savanna, Summit, Palos Park, Moline, Rock Island, Le Roy, Havana, Georgetown, Muncie, Oakwood, Homer, Urbana, Champaign, Mahomet, Seymour, White Heath, Charleston, Taylorville, Alton, Lawrenceville, Tonti, Mt. Carmel, Crossville, Mt. Vernon, Dubois, Shawneetown, Carbondale, Makanda, Murphysboro, Fountain Bluff, Grand Tower, Herod, Williams Mountain, Alto Pass, Cobden, Aldridge, Elizabethtown, Golconda, Dixon Springs, Metropolis, New Columbia, Vienna, Karnak, East Cape Girardeau, Villa Ridge, Cairo. Of this series five males and 36 females are of the green color phase.

Encoptolophus Scudder

E. sordidus sordidus (Burmeister).—This species is distributed over practically all the state. In the middle and northern sections it is decidedly more abundant than in the southern portion.

Forty-two males and 41 females taken August 14 to November 26, the majority in September, and two immature specimens were captured at Kenilworth, Winnetka, Chicago, Algonquin, Downers Grove, Starved Rock, Moline, St. Anne, Homer, Urbana, Champaign, Athens, Borton, Charleston, Casey, Hillsboro, Lawrenceville, Alma, Metropolis.

Camnula Stal

C. pellucida Scudder.—Evanston, Ill. and Bass Lake in Starke county, Ind. are southern limital points. Scudder incorrectly recorded it from southern Illinois in 1874. The following are the first valid records for the state.

Kenilworth: June 21 to July 18, 1899, 9♂, 8♀. **Evanston:** Aug. 16, 1901, 1♂, Hancock.

Hippiscus Saussure

H. rugosus (Scudder).—The species was recorded as *corallipes* in 1876 and as *corallipes* var. *rugosus* in 1880 by Thomas and correctly in 1891 by McNeill and in 1913 by Vestal. Scudder (1892), in his revision of *Hippiscus*, reported it from southern Illinois correctly and as the synonyms *variegatus* (in part) and *suturalis*. It was recorded both correctly and as *suturalis* by Hart in 1907.

The northern limits of *rugosus* will probably be found to reach little north of the northern boundary of Illinois. Chana is at present a northern limit in this longitude.

Thirty-seven males and 31 females, taken July 22 to October 13, and six immature individuals were secured at the following localities: **Chicago**, wing disk buff yellow in all; **Chana**, wing disk strawberry pink in 1♂; **St. Anne**, wing disk yellow in 1♀, pink in 1♂ and 3♀; **Havana**, wing disk pale sulfur yellow in 1 pair, light viridine yellow in 1♀, light orange yellow in 1♀, strawberry pink in 1♂; **Muncie**, wing disk sulfur yellow in 1♂, apricot

yellow in 2♂, grenadine in 2♂; **Homer**, wing disk pale viridine yellow in 1♂ and 2♀, strawberry pink in 1♂; **Urbana**, wing disk peach red in 1 pair; **Champaign**, wing disk strawberry pink in 1♀, pale viridine yellow in 1♀, buff yellow in 1♀; **Borton**; **Hillsboro**; **Grafton**, wing disk sulfur yellow in 1♀; **Alton**, wing disk sulfur yellow in 2♂; **Lawrenceville**; **Clay City**, wing disk grenadine in 1♀, sulfur yellow in 1♀; **Alma**; **Dubois**, wing disk sulfur yellow in 1♂; **Carbondale**, wing disk sulfur yellow in 1♂, apricot yellow in 1♂; **Running Lake**; **Murphysboro**, pronotal collar pale, wing disk pale viridine yellow in 1♂; **Grand Tower**, wing disk buff yellow in 1 pair; **Anvil Rock Hills**, wing disk apricot yellow in 1♀; **Herod**; **Alto Pass**; **Golconda**; **Dixon Springs**; **Metropolis**, wing disk buff yellow in 1♂, apricot yellow in 1♀; **Whitehill**; **Cairo**.

Pardalophora Saussure

KEY TO SPECIES

1. Fastigium narrowing evenly distad, more produced, fig. 55. Pronotal disk finely granulose. Caudal femora broad with lamellate margins, inner surface buffy with very dark brown markings. Tegmina with a distinctive pattern, in part irregularly maculate. Wing disk pink to deep pink. Caudal tibiae buff..... **apiculata**, p. 182
Fastigium narrowing less evenly distad, less produced, fig. 54..... 2
2. Caudal femora broad with lamellate margins, inner surface very deep bluish with a broad apical annulus of buff or pinkish. Tegmina irregularly maculate. Wing disk normally deep pink, very rarely pale yellow. Caudal tibiae buff. Pronotal disk with scattered granules..... **phoenicoptera**, p. 182
Caudal femora much narrower, inner surface normally buff, occasionally pink. Tegmina more regularly contrastingly and extensively maculate. Wing disk yellow to pink. Caudal tibiae normally buff, occasionally pink. Pronotal disk more coarsely and conspicuously rugoso-granose..... **haldemanii**, p. 183

P. apiculata (Harris).—This species was recorded as *Hippiscus phoenicopterus* by Thomas (1876) and McNeill (1891) and has subsequently been repeatedly recorded as *Hippiscus tuberculatus*.

Beach: May 25, 1931, 1♂, 1♀, Benesh. **Algonquin**: May 5 to June 14, 1907 to 1910, 3♂, 14♀, caudal tibiae buff. **Oregon**: May 12, 1915, 1♂, caudal tibiae buff. **Grand Detour**: May 19, 1931, 1♂, caudal tibiae buff, Frison. **Sterling**: May 12, 1915, 2 juv. **Rock Island**: May 8, 1887, 1♀ recorded as *phoenicopterus*, McNeill. **Kappa**: June 6, 1883, 1♀. **Forest City**: June 6, 1905, 1♂. **Havana**: May 30, 1911, 1♀. **Equality**: June 22, 1927, 1♂, caudal tibiae buff tinged with tawny, Frison. **Herod**: June 24, 1932, 1♂, caudal tibiae buff, Ross and Dozier. **Alto Pass**: Apr. 17, 1927, 1♂, 1♀, caudal tibiae deep peach red.

P. phoenicoptera (Burmeister).—Uniformity in the coral red wing disk (maximum recession causing only moderate paling to coral pink) and the blue of the dark markings on the inner side of the caudal femora are outstanding features of the species. The caudal tibiae vary from buff to light salmon orange and are usually lightly

suffused with brown distad on the outer side. A color phase in which the head except the mouthparts, pronotum and dorsal and ventral outer margins of the caudal femora are washed with jade green is shown in varying intensity by six males and two females, while in a few females the head, pronotum and outer surface of the caudal femora are almost immaculate, individually varying from deep wood brown to clay color.

This species is local in distribution and abundantly present only in the spring. The present long series of this large and handsome insect would not have been secured had it not been taken in considerable numbers on the several occasions when found.

Fulton and St. Joseph are known northern limits, the species following the Mississippi valley northward in the western portion of the state. It is probably absent from northeastern Illinois.

It was reported as the synonym *discoideus* by Thomas in 1876 and 1880.

Eighty-one males and 39 females taken June 4 to August 13, almost all in June, and 1 half-grown juv.♀ secured July 20 are from **Fulton, Forest City, Bishop, Topeka, Havana, St. Joseph, Arenzville, Meredosia, Carbon-dale, Grand Tower, Anvil Rock Hills, Parker, Alto Pass.**

P. haldemanii (Scudder).—The inner and ventral portions of the caudal femora, normally buff, occasionally show dark suffusions but never a trace of blue. In some of the present series these portions are tinged with peach red to varying degrees and in one male from Topeka are uniform scarlet red, a very unusual condition in this species. The caudal tibiae are either clear buff or tinged similarly with peach red or light scarlet red; in the latter case always paling on the inner proximal side. In the series six males and seven females have the wing disk barium yellow, a very pale shade, all the others having it pink, pale geranium pink to rose doré.

Thomas recorded his *Hippiscus neglectus* in his Illinois list of 1880 and Scudder stated in 1892 that the material is labeled "Southern Illinois" and represents the present species. If this is true we believe the locality labeling to be incorrect. We have a female from Rock Island which McNeill in 1891 probably confused with his *H. tuberculatus* (= *P. apiculata*). The species was correctly reported by Hart in 1907 and by Vestal in 1913.

In Illinois this insect is known only from the central and northern portions, confined largely to sand areas. Its easternmost point of distribution is Pine in Lake county, Ind. A series is also before us from Lone Rock, Wis.

Twenty-six males and 24 females taken May 30 to August 28, almost all in June, are from **Chicago, Algonquin, Fulton, St. Anne, Forest City, Bishop, Topeka, Havana, Mason City.**

Dissosteira Scudder

D. carolina (Linnaeus).—This species, the dusty roadside grasshopper, is one of the commonest species in the state.

Thirty-four males and 17 females of this ubiquitous species, taken June 18 to September 9, and 15 immature individuals secured June 5 to July 27, are from **Beach, Zion, Waukegan, Kenilworth, Winnetka, Chicago, Antioch, Wauconda, Algonquin, Chana, Amboy, Savanna, Downers Grove, Lemont, Milan, Kankakee, St. Anne, Peoria, Tremont, Elliott, Forest City, Havana, Hamilton, Muncie, Homer, Urbana, White Heath, Decatur, Pike, Grafton, Alton, Lawrenceville, Centralia, Dubois, Shawneetown, Grand Tower, Herod, Alto Pass, Elizabethtown, Golconda, Dixon Springs, Whitehill, Cache.**

Spharagemon Scudder

KEY TO SPECIES

Caudal tibiae pink, with a broad brown annulus after the proximal buffy annulus.

Pronotum with median carina weak. Tegmina weakly banded.....**bolli**

Caudal tibiae pink, with only a proximal buff annulus. Pronotum with median carina strong. Tegmina with partial banding indicated, often dotted....**collare**

S. bolli Scudder.

Thirty-eight males and 27 females, taken July 25 to October 20, and two immature examples are from **Beach, Lake Forest, Winnetka, Chicago, Antioch, Barrington, Downers Grove, Muncie, Oakwood, Urbana, Champaign, Charleston, Grafton, Dubois, Fountain Bluff, Herod, Prospect Hill, Alto Pass, Jonesboro, Golconda, Dixon Springs, Metropolis.**

S. collare (Scudder).—This species is confined to sand areas or regions of sandy soil.

Stal in 1873 described *Oedipoda belfragii* from Illinois, a name we placed as a synonym of the present species in 1929. Hart in 1907 and Vestal in 1913 recorded *collare* as *wyomingianum*, a name synonymized by Kirby in 1910. Blatchley resurrected this name in 1920 and the author again placed in it synonymy in 1925b.

Seventy-five males and 54 females, taken June 23 to September 22, were captured at **Beach, Zion, Waukegan, Winnetka, Chicago, Fox Lake, Algonquin, Fulton, Starved Rock, Moline, St. Anne, Bishop, Topeka, Havana, Augerville, Arenzville.**

Trachyrhachis Scudder

KEY TO SPECIES

Wing band varying from obsolete, almost obsolete to broken but moderately broad (normally not very broad).....**kiowa thomasi**, p. 184

Wing band very broad and heavy.....**kiowa fuscifrons**, p. 185

T. kiowa thomasi (Caudell).—This may be a race intermediate between *kiowa kiowa* of the northern great plains and *kiowa fuscifrons*,

found in the southern and southeastern portions of the species distribution, or it may simply be a transitional condition between those races.

In the present series one female has the pronotal metazona light yellowish olive but whitish cephalad on the disk, another has a white saddle cephalad on the disk of the metazona. All have a yellow wing disk. The wing band is almost obsolete in four females, weak to varying degrees in the majority, broad but mottled in two females, the latter rather representing *kiowa fuscifrons*. To *kiowa thomasi* we also refer two males and six females from Lone Rock, Wis., taken July 28 to August 24. In these the wing disk is yellow, the band practically obsolete in one female, very faint in one female, weak in two males and three females and moderately strong in one female.

Havana: Aug. 12 to Sept. 11, 12♂, 18♀. **Alto Pass:** Aug. 13, 1891, 1♂ top of Bald Knob, Hart. **Metropolis:** Aug. 17, 1891, 1♀. Hart and Shiga.

T. kiowa fuscifrons (Stal).—Dr. J. Carl has kindly examined the type of *Psinidia fuscifrons* var. *texana* Saussure from Dallas, Tex. in the Geneva Museum and states that it is smaller but otherwise similar to the balance of the series from Dallas, Tex. assigned to *fuscifrons*. His sketch shows the wing band to be broad and solid as in that insect and we are satisfied that *texana* must be placed as a synonym.

Under *kiowa thomasi* we note that the majority of the series from Havana, Ill. and Lone Rock, Wis. are typical of that race, but that in each case there are specimens referable to *kiowa fuscifrons*.

We believe that the present race will be found everywhere in southern Illinois, intergrading with *kiowa thomasi* through the other portions of the state.

A series taken June 24 to September 5 is from **Havana, Grafton, Dubois, Carbondale, Murphysboro, Grand Tower, Prospect Hill, Williams Mountain, Elizabethtown, Metropolis, Whitehill.**

Psinidia Stal

P. fenestralis fenestralis (Serville).—The present series has the wing disk varying only slightly, from bittersweet orange to light grenadine pink.

The species is confined to sandy areas and is probably present locally throughout the state though it is as yet not known here south of Meredosia.

Fifty-nine males and 56 females were secured from July 20 to September 2 at **Beach, Waukegan, Chicago, Amboy, Fulton, Moline, Forest City, Bishop, Topeka, Havana, Meredosia.**

⁶Curator, Geneva, Switzerland, Museum of Natural History.

Trimerotropis Stal

Though typically widely different in appearance, both *citrina* and *maritima interior* are in some places subject to very decided individual variation and are sometimes extremely difficult to distinguish. A key cannot therefore be entirely relied upon.

KEY TO SPECIES

1. Dark brown and whitish markings in sharp contrast, the latter often faintly tinged with green. Ventral surface of caudal femora black with a preapical buffy band. Caudal tibiae buffy faintly tinged with green, with a broad buff proximal annulus, suffused beyond this and at apex with brown. Smaller species. Inhabits rocky hills.....*saxatilis*, p. 186
Never as dark or as contrastingly marked, colors light and dark shades of brown. Caudal tibiae pink or buff. Larger species. Inhabits sandy areas.....2
2. Generally brown finely tessellate with slightly darker areas. Form slightly more graceful. Caudal tibiae pink.....*citrina*, p. 186
Generally brown with darker areas and whitish suffusions and flecking. Form slightly more robust. Caudal tibiae usually buff, sometimes pink.....
.....*maritima interior*, p. 187

T. saxatilis McNeill.—Five males from Union county, originally described by McNeill (1901) are in the present collections. The lectotype was selected by Frison (1927) as the male taken there on July 23, 1884 by G. H. French; the other four are paratypes taken July 23 and 31, 1880. Additional material was recorded from Arkansas with McNeill's original description.

This insect is very local, inhabiting rocky outcrops in hilly country. In Illinois it is known only from the southern portion of the state.

Anvil Rock Hills: Aug. 10, 1905, 5♂, 7♀; Aug. 23, 1900, 1♀, Hart.

Prospect Hill: Aug. 13, 1905, 1♂. **Wamble Mountain:** Aug. 12, 1905, 3♂, 2♀.

T. citrina Scudder.—Thomas in 1876 recorded *Trimerotropis verrucullata* and McNeill in 1891 reported *Circotettix verrucullatus* from Henry, Ill. and Birds Point, Mo. McNeill in 1901 was incorrect in supposing that Thomas' material represented *saxatilis*. These records we now find to have been based on dried alcoholic material of the present species. Known correct southern limital points for *Circotettix verrucullatus* (Kirby) are the upper peninsula of Michigan and Hinckley, Minn. The species certainly does not reach south of the boreal coniferous forests. Not even in his 1901 revision of the genus did McNeill discover that *citrina* occurred in Illinois but we believe it quite probable that it was this insect which Thomas (1878) may again have reported as *Oedipoda aequalis*.

Though widely distributed over the sandy fields of the southeast, this species is probably largely confined to sandy areas along the rivers

in Illinois, where it is known as far north as Algonquin. It is distributed along the Ohio river east to Vevay, Ind. Somes' records (1914) from southeastern Minnesota are however referable to *Trimerotropis maritima interior*.

Algonquin: July 24 and 25, 1910, 3 ♂, Nason. **Savanna:** Aug. 1, 1892, 1 ♂, McElfresh. **Henry:** July 15, 1878, 1 ♀, dried alcoholic. **Havana:** Aug. 12, 1903, Aug. 14, 1907 and Aug. 22, 1912, 2 ♂, 1 ♀, in sandy waste and on river shore. **Meredosia:** Aug. 19, 1917 and Aug. 29, 1905, 2 ♂, 1 juv. ♀. **Quincy:** Sept. 6, 1887, 1 ♂ on sand bar. **Grand Tower:** June 24 to Aug. 8, 1891 to 1909, 9 ♂, 9 ♀.

T. maritima interior E. M. Walker.—Material before us was reported as *maritima* by Thomas in 1880 from extreme northern Illinois, but McNeill did not have it from the state though giving "Illinois" in the distribution of *maritima* in 1901.

This race has been fully discussed by Hubbell (1929) and to some extent by Somes (1914). It is known only from areas of bare sand along the shores of Lake Michigan in extreme northeastern Illinois but it may be present on the sand shores of lakes and streams in the northern portion of the state as it is known northwestward in southeastern Minnesota and as far as Mullvany Lake, near Willow Bunch in south-central Saskatchewan.

The caudal tibiae of the present series are whitish proximad, thence primrose yellow but usually slightly suffused with brownish distad; they are tinged with ochraceous salmon in a single pair from Waukegan.

Beach: Aug. 24, 1906, 1 ♂, 1 ♀, on sand ridges. **Waukegan:** Aug. 16 to 23, 1906 and 1908, 11 ♂, 21 ♀. **Winnetka:** Aug. 22, 1897, 1 ♀, Hancock. **Chicago:** Sept. 1, 1897, 1 ♂ in Windsor Park, Hancock.

CYRTACANTHACRINAE

Leptysma Stal

L. marginicollis (Serville).—This species has been reported from the Wabash river bottoms in Vigo county, Ind., where it was found in sedges and rushes, so that it is certain to be located in similar environments in southern Illinois.

Schistocerca Stal

KEY TO SPECIES

1. Cerci of male narrowing slightly but distinctly distad, fig. 53. Pronotal disk weakly convex. Large. Brown, with a distinctive and conspicuous pattern of yellowish and whitish stripes and with dark brown spots in discoidal field of tegmina. Male subgenital plate bluntly V-emarginate.
 *americana americana*, p. 188

SCHISTOCERCA—KEY TO SPECIES—CONT'D

- Cerci of male not narrowing distad, fig. 49. Pronotal disk moderately to decidedly tectate.....2
2. Cleft of male subgenital plate very narrow, fig. 59. Smaller. Form short and stocky. Antennae of male not over one-fifth longer than head and pronotum. Usually almost uniform light brown.....**damnifica damnifica**, p. 188
- Cleft of male subgenital plate not as narrow, fig. 60. Larger. Form more elongate and graceful. Antennae of male more elongate.....3
3. Lateral fields of tegmina usually mottled, when clear never deep purplish brown. Caudal tibiae reddish yellow or pale brown. Lateral projections of apex of male subgenital plate of moderate size. Medium large.....**alutacea**, p. 189
- Lateral fields of tegmina clear deep purplish brown. Caudal tibiae blackish purple. Lateral projections of apex of male subgenital plate very large. Large.....**obscura**, p. 189

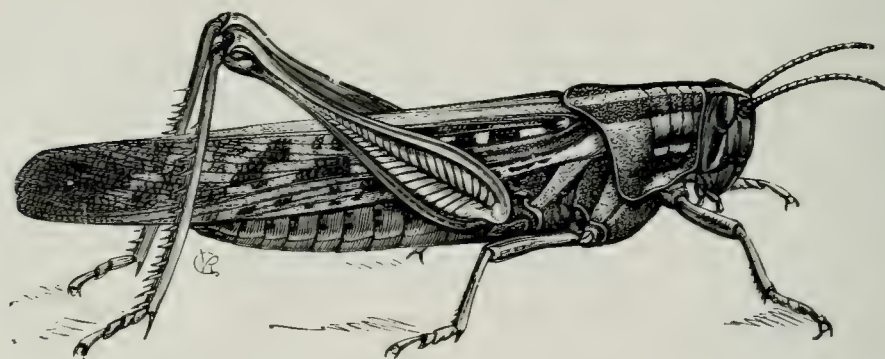


Fig. 157.—The long winged grasshopper *Schistocerca americana americana* (Drury). (After Thomas, 9th Report State Ent. Ill.) $\times 1$.

S. damnifica damnifica (Saussure).—Clarksville is a northern limit point, the species being confined to southern Illinois.

Clarksville: June 14, 1933, 1♂, Frison and Ross. **Albion:** Aug. 22, 1887, 1♀, Weed. **Shawneetown:** Oct. 12, 1932, 1♂, Frison and Ross. **Carterville:** May 11, 1887, 1♀, Ward. **Herod:** Sept. 4, 1932, Ross and Horsfall. **Eichorn:** Apr. 20, 1932, 1♀, Ross and Mohr. **Parker:** Apr. 17, 1914, May 23, 1923 and June 12, 1907, 5♂. **Alto Pass:** Apr. 17, 1927, 1♂, Frison. **Anna:** Apr. 20, 1886, 1♀, Weed. **Golconda:** Oct. 13, 1932, 1♂, 1♀, Frison and Ross.

S. americana americana (Drury).—We had believed that this species would not be found north of central Illinois except during its fall migrations, when individuals are known to fly far north of the area of continuous distribution, but a female was secured at Chicago, a northern limit, by G. C. Thompson in Grant Park on May 3, 1922. Two other females were taken there in Windsor Park by J. L. Hancock, September 20 and 27, 1894.

Sixteen males and 15 females, taken May 14 to October 11, are from Chicago, Urbana, Champaign, Decatur, Jewett, Nokomis, Carlinville, Alton, Lawrenceville, St. Francisville, Mt. Carmel, Dubois, Shawneetown,

Makanda, Hicks Branch, Eichorn, Jonesboro, Golconda, Dixon Springs, Metropolis, Villa Ridge, Cache.

S. alutacea (Harris).—The present series includes about an equal number of unicolorous and strongly vittate phases, with individuals showing every intergradation between the two.

Sixty-seven males and 49 females, taken July 28 to September 9, are from Beach, Zion, Waukegan, Chicago, Dixon, Amboy, Fulton, Colona, Moline, St. Anne, Normal, Forest City, Bishop, Topeka, Havana, Bath, Meredosia, Clay City, Williams Mountain, Cobden, Metropolis.

S. obscura (Fabricius).—The following is a northern limit for this handsome species, previously not known from Illinois and probably confined to the extreme southern portion of the state.

Ware: Sept. 21, 1931, 1♀, Mohr.

Campylacantha Scudder

C. olivacea olivacea (Scudder).—This species was recorded correctly and as the synonym *acutipennis* by Hart in 1907 and by Vestal in 1913.

Four males and two females of the present series are brown, the others are light green. Havana and Clay City are northeastern known limits for this race.

Seventeen males and 14 females, taken August 12 to October 12, and eight immatures are from Forest City, Topeka, Havana, Meredosia, Edgewood, Clay City, Ashley, Dubois, Eldorado, Marion, Herrin.

Hesperotettix Scudder

KEY TO SPECIES

Prozona smooth. A median line on pronotum and often dorsal fields of tegmina purplish pink. Pronotal lateral lobes usually with a dark marking. Caudal femora with outer side often maculate and with a subapical pink annulus. Decided color variation occurs. Small. **viridis pratensis**, p. 189

Prozona with a network of very low, even rugae. A median line on pronotum and along outer dorsal margin of caudal femora purplish pink. Caudal femora otherwise and tegmina immaculate. Larger. **speciosus**, p. 190

H. viridis pratensis Scudder.—This beautiful insect, usually scarce and always very local, occurs everywhere in Illinois. A series before us from Lone Rock, Wis. is from a northern limital point.

The race was recorded as *pratensis* by Hart in 1907 from Waukegan, Havana, Chautauqua and Grafton.

Beach: Aug. 22 to 28, 1906 to 1932, 20♂, 15♀. Zion: Aug. 25, 1932, 3♂, 3♀, Ross and Mohr. Waukegan: Aug. 18 to 25, 1906 and 1917, 3♂, 2♀. St. Anne: Aug. 28, 1932, 1♀, Ross and Mohr. Havana: Aug. 18, 1903, 4♂, 8♀, Hart. Chautauqua: July 20, 1906, 1♂. Dubois: June 22, 1905, 2♂, 2♀; Aug. 9, 1917, 1♂, 1♀. Baldwin: Sept. 1, 1908, 1♀.

H. speciosus (Scudder).—This species was first recorded from Illinois by Hart in 1907.

The following are eastern limits of distribution for this western species and the only ones known for it east of the Mississippi. It will however probably be found locally in similar sand areas west and south of these.

Devil's Hole: Aug. 7 to Sept. 2, 1905 to 1912, 1♂, 7♀. **Devil's Neck:** Aug. 17 and 22, 1904 to 1912, 2♂, 4♀. **Edgewood:** Aug. 21, 1886, 1♀, Garman.

Melanoplus Stal

KEY TO SPECIES

1. Organs of flight showing marked reduction, similar to fig. 156.....2
Organs of flight not reduced (see exceptions under 2 in *scudderi scudderi*,
dawsoni, *borealis junius* and *fasciatus*).....11⁷
2. Tegmina represented by pads, fig. 64.....3
Tegmina in repose with a distinct angle between dorsal and discoidal areas,
fig. 65; sometimes fully developed in *fasciatus* and *borealis junius*.....8
3. Tegmina represented by slender elongate pads, fig. 57, not reaching beyond
first abdominal segment. Caudal femora green with apices dark. Caudal
tibiae green with immediate bases dark.....*gracilis*, p. 192
Tegmina represented by ovate or lanceolate pads, figs. 58, 64, reaching to at
least second abdominal segment.....4
4. Caudal tibiae green. Sylvan species.....5
Caudal tibiae pink.....7
5. Caudal femora greenish, heavily marked with blackish brown. Male furcula
minute.....*viridipes viridipes*, p. 192
Caudal femora brown, the dorsal surface alone weakly marked with darker
brown. Male furcula heavier.....6
6. Male cerci with apices truncate, fig. 73. Male furcula of moderate size, slender,
tapering regularly. Male subgenital plate short, truncate.....
.....*obovatipennis*, p. 193
Male cerci with elongate, spatulate, rounded apices, fig. 78. Male furcula
longer, heavy proximad, slender distad. Male subgenital plate more
elongate, convex.....*morsei*, p. 193
7. Tegmina represented by ovate pads, fig. 64, organs of flight very rarely fully
developed. Male furcula very small. Male cerci longer, broader, less bent,
fig. 67. Larger. General coloration usually light brown, abdomen not
ringed, ventral surface buff. Prefers open weedy areas.....
.....*scudderi scudderi*, p. 194
Tegmina represented by lanceolate pads, fig. 58, organs of flight rarely fully
developed. Male furcula large. Male cerci smaller, more bent, fig. 71. Smaller.
General coloration usually darker brown, abdomen usually appearing ringed,
ventral surface yellow buff. Sylvan.....*dawsoni*, p. 196

⁷No satisfactory key for separating females of all the species of this section of *Melanoplus* can yet be supplied.

MELANOPLUS—KEY TO SPECIES—CONT'D

8. Male cerci with apex not markedly spatulate, figs. 70, 77, broad and gradually narrowing but stil. broad distad with apex dorsad. Caudal femora without conspicuous outer markings.....9
 Male cerci with apex extremely broad and spatulate, figs. 82, 83. Caudal femora dark with three conspicuous pale areas on outer surface. Larger. Form more robust. Spatulate apex of male cerci short.....10
9. Male furcula large, fig. 91. Male subgenital plate margined with black. Caudal tibiae pale glaucous, buffy or pink.....*borealis junius*, p. 197
 Male furcula minute, fig. 92.....*fasciatus*, p. 197
10. Male furcula stout, fig. 90. Male cerci large, with apex bent inward, fig. 83. Medium large for genus. Caudal tibiae pink, suffused proximad beyond a broad pale subproximal annulus.....*walshii*, p. 194
 Male furcula subobsolete, fig. 89. Male cerci very large, with apex not bent inward, fig. 82. Large for genus. Caudal tibiae orange buff or pink, suffused proximad beyond a broad pale subproximal annulus.....
 *ponderosus viola*, p. 194
11. Male cerci with a lateral projection, or forked, figs. 85-88.....12
 Male cerci simple or with merely expanded apices, figs. 67, 84.....15
12. Male cerci with a projecting angulation of the ventral margin, figs. 85, 87....13
 Male cerci forked, the ventral arm slender and finger-like, fig. 88. Caudal tibiae rich pink. Male furcula minute.....*keeleri luridus*, p. 198
13. Dorsum of pronotum and tegmina without lateral stripes, uniformly greenish or yellowish olive hues.....14
 Dorsum of pronotum and tegmina with a longitudinal light stripe along the dorsolateral angle.....*bivittatus*, p. 195
14. Caudal tibiae yellowish buff, always except in California. Male furcula subobsolete. Male cerci with a rounded projection mesad on ventral margin, fig. 87. Very large. Appears adult in summer.....*differentialis*, p. 195
 Caudal tibiae pink or glaucous. Male furcula heavy, its arms parallel. Male cerci with an obtuse angulation about middle of ventral margin, fig. 85. Medium small. Appears adult in spring.....*confusus*, p. 196
15. Male cerci with apices conspicuously expanded, figs. 79, 81.....16
 Male cerci with apices not or only little expanded, figs. 67, 77. Male furcula large.....18
16. Male cerci with apices only moderately expanded, fig. 79.....17
 Male cerci with apices greatly expanded, fig. 81. Male furcula minute. Caudal tibiae pink or very hirsute. Medium size. Gray and mottled like bark, not striped. Caudal femora deep pink on outer and ventral surfaces. Arboreal.
 *punctulatus punctulatus*, p. 196
17. Male subgenital plate with apex undivided, fig. 93. Apices of male cerci short, definitely spatulate, fig. 79, with dorsal and ventral margins rounded and distal margin truncate. Antennae very elongate for genus. Caudal femora with transverse bands only. Caudal tibiae glaucous, buffy or pink. Male furcula small, strongly divergent. River valley inhabitant.*foedus fluviatilis*, p. 198
 Male subgenital plate with twin rounded apices, due to a mesodistal impression, fig. 94. Male cerci with shaft moderately broad and apical expansion

MELANOPLUS—KEY TO SPECIES—CONCL'D

- normally slightly greater ventrad than dorsad. Male furcula well developed. Small. Form comparatively graceful. Caudal tibiae glaucous or pink.
**angustipennis**, p. 198
18. Male cerci elongate and very slenderly cylindrical, figs. 74, 75.....19
 Male cerci broad, flattened, tapering to the broadly rounded apices, figs. 69, 84. Medium small to small.....20
19. Apices of male cerci rounded, fig. 74, with merest trace of thickening. Medium size. Form graceful. Caudal tibiae rich glaucous. **flavidus flavidus**, p. 199
 Apices of male cerci acute, fig. 75, elongate and lamellate. Antennae normal. Caudal femora with two dark bands oblique on external pagina. Caudal tibiae rich pink. Male furcula small, its arms parallel. Sandy pine woods inhabitant.....**impudicus**, p. 196
20. Male subgenital plate not produced dorsocaudad, with undivided apex, fig. 93. Male cerci elongate and slender, fig. 69. Caudal tibiae pink, very rarely buff or glaucous.....**femur-rubrum femur-rubrum**, p. 197⁸
 Male subgenital plate moderately produced dorsocaudad, with twin apices, due to a mesodistal impression, fig. 94. Male cerci considerably shorter and wide, fig. 84. Caudal tibiae in majority from Illinois pink, occasionally buff, frequently glaucous.....**mexicanus mexicanus**, p. 197

M. gracilis (Bruner).—Though undoubtedly this species occurs over all of Illinois, Kenilworth is as yet a northern known limit point of distribution.

Thomas described the synonym *Pezotettix minutipennis* from Normal in 1876.

Thirty-three males and 31 females, taken June 21 to October 31, and one immature specimen are from **Kenilworth, Bloomington, West Havana, Hilliary, Muncie, Homer, Urbana, Mahomet, Charleston, West Union, Chatauqua, Mt. Carmel, Dubois, Shawneetown, Dixon Springs, Karnak.**

M. viridipes viridipes Scudder.—This race was recorded as *Pezotettix viridulus* (in error for the unpublished name *Pezotettix viridicrus* of Walsh) by McNeill in 1891 from Normal and Bloomington. In 1897 *viridipes* was described, Illinois material being from Rock Island, Moline and Ogle county, and in 1912 Rehn and Hebard selected the type, a male from Moline.

In 1920 Hebard described the eastern race *viridipes eurycerus* and found the area of intergradation between these races to extend through Wisconsin, southern Michigan and western Indiana.

The race probably is found over all of Illinois, though in the extreme northern and the extreme eastern portions of the state atypical colonies may occur. The present series is typical, only occasional males having the cerci as long as but slightly heavier than the normal.

⁸Females are distinguishable from those of *mexicanus*, both very common campestran species, only by having in *femur-rubrum* the tegmina averaging slightly broader and less maculate, the prosternal spine stouter and the distal curvature of the dorsal ovipositor valves broader.

Eighty males and 58 females, taken May 27 to October 26 but the large majority in June, and two immatures are from Zion, Lake Forest, Glenview, Rockford, Oregon, Mt. Carroll, Savanna, Riverside, Riverdale, Palos Park, Moline, Kankakee, Bloomington, Normal, Muncie, Oakwood, Homer, St. Joseph, Urbana, White Heath, Monticello, Kampsville, Dubois, Grand Tower, Pulaski.

M. obovatipennis Blatchley.—Scudder figured in 1897 the apex of the male abdomen of the type of Stal's *Pezotettix rusticus*, described in 1878 from Texas, probably from the vicinity of Dallas, but material from Dallas was at that time referred to *obovatipennis*. Comparison of large series now before us from Ohio and Tennessee to Iowa, Missouri and northeastern Texas shows that except for features of size and coloration such material is inseparable. Texan specimens do have however the divided median production of the penis with its parts separated and somewhat enlarged. As a result, until thoroughly revised we believe that *obovatipennis* should be recognized, though the name will quite probably prove to have no more than racial status and is possibly a synonym of *rusticus*.

This insect is known north to Ohio; the localities Lafayette, Ind., Savanna, Peoria and Hilliary, Ill. and Hamburg, Iowa are represented by specimens before us. A southern limit is Clarksville, Tenn., but southwestward the *rusticus* problem prevents other limits being given at the present time.

Forty-eight males and 50 females and eight immature individuals of this handsome insect, found in or near forests, were taken August 8 to October 11 from Savanna, Central, Benson, Bartonville, Peoria, Hilliary, Charleston, Grafton, Clay City, Dubois, Zeigler, Shawneetown, Grand Tower, Prospect Hill, Herod, Golconda, Dixon Springs, Metropolis, Cache, Thebes. A large series is from Hilliary on October 11.

M. morsei Blatchley.—A pair was recorded from Running Lake by McNeill in 1891 as *Pezotettix manca*, which material he referred to *Melanoplus obovatipennis* in 1899. Though the male genitalia are very different, females of *morsei* are difficult to distinguish from those of *M. obovatipennis*. The former are best separated by being normally slightly more graceful, the pronotum showing a slightly greater tendency toward constriction cephalad, the tegminal pads usually separated by a narrower interval, the caudal femora showing very feeble marking and the dorsal ovipositor valves appreciably narrower in proximal portion with margin there normally smoother, and distad curving more gently into the slightly longer and more weakly recurved apical portion. Furthermore, *morsei* appears in greatest adult abundance in the spring and early summer, while *obovatipennis* so appears in the summer and early fall.

Though Morse's *tepidus* is very closely related to *morsei*, they are much more widely separated from *obovatifennis* than Morse (1907) supposed, a fact noted by Blatchley in 1920.

This distinctive and apparently rarer sylvan species, also known from Hocking county, Ohio and from near Bedford and Wyandotte in southern Indiana, is apparently confined to extreme southern Illinois, Carbondale being a northern limit. Its distribution southward and westward is extensive, Hattiesburg, Miss. being a southwestern limit. Morse's pair from there is typical but very large.

Carbondale: June 26, 1907, 1♂, 1♀. **Running Lake:** July 15, 1883, 1♂. **Hicks Branch:** June 24, 1932, 1♀, Ross, Dozier and Park. **Alto Pass:** Aug. 13, 1891, 1♂, 1♀, Hart and Shiga. **Thebes:** July 31, 1905, 1♂.

M. scudderi scudderi (Uhler).—Part of the originally described series came from Rock Island. The race has also been reported from Illinois as the synonym *Pezotettix unicolor* Thomas.

Sixty-four males and 66 females, taken August 11 to October 31, are from **Beach, Waukegan, Kenilworth, Colona, Milan, Benson, Bartonville, Bloomington, Forest City, Topeka, Havana, West Havana, Hilliary, Muncie, Homer, Urbana, White Heath, Arenzville, Charleston, Neoga, Grafton, Clay City, Norris City, Dubois, Shawneetown, Herod, Alto Pass, Elizabethtown, Golconda, Dixon Springs, Metropolis, Cache.**

M. walshii Scudder.—The species has been reported from Illinois by McNeill (1891) as Bruner's *Pezotettix occidentalis* (not *Caloptenus occidentalis* Thomas) and by Scudder (1897) under Scudder's new name *blatchleyi*, now included in the synonymy of *walshii*.

In extreme southern Illinois the insect averages very large.

This handsome forest and bog loving insect is represented by 37 males and 41 females, taken June 21 to October 13, the majority late in the season, from **Lake Forest, Antioch, Sun Lake, Deep Lake, Long Lake, Algonquin, Savanna, Downers Grove, Moline, Bartonville, Havana, Charleston, Grafton, Alton, Dubois, Shawneetown, Herod, Golconda, Dixon Springs, Metropolis, Vienna, Karnak, Pulaski, Cache, Thebes.**

M. ponderosus viola (Thomas).—This race, described from central and southern Illinois as *Pezotettix viola* by Thomas in 1876, was so recorded from Running Lake by McNeill in 1891. In 1920 Blatchley considered it to be merely a short winged form of *ponderosus*, but later that year we assigned it as a race of that species (Hebard 1920, p. 370, footnote 18).

In the present series the caudal tibiae are usually orange buff, rarely pink, becoming suffused proximad and there with a broad subproximal pale annulus.

We believe that the insect occurs in Illinois only in the southern part. Thomas' record from central Illinois is apparently based upon a

male before us from the Thomas collection labeled "Peoria, IX, 24, 1877." This labeling we believe is incorrect. This specimen, apparently taken a year after the species was described, and a female labeled 819P, are all that remain in the collection of the original describer at the ILLINOIS STATE NATURAL HISTORY SURVEY, nor is any of Thomas' material at the National Museum where many of his types are preserved.

Known northern limits are Tyrone, Ky., Grafton and Mt. Carmel, Ill. and St. Louis and Willard, Mo., judging from large series before us. Though Tyrone, Ky. is an eastern limit and the race probably occupies a moderately wide area to the south, there are no other records from that section of its distribution. From Memphis, Tenn. south through Mississippi and southeastern Louisiana the species is supplanted by the closely related *tunicae* Hebard. Morse's record of *viola* in 1907 from Hattiesburg, Miss. was based on material of *tunicae*.

Westward it is known as far as Willard, Mo. and Cane Hill, Ark. but probably most of the latter state, eastern Oklahoma and all but southeastern Louisiana are in the area of intergradation with *ponderosus ponderosus*, which race occurs in the western portions of Texas and Oklahoma. Bruner's record of *viola* from southeastern Nebraska is almost certainly based on material which was either incorrectly determined or labeled. This race is not even known from southeastern Kansas, though it may occur there.

This insect lives in undergrowth growing on low ground in forests and is very local. Diligent search however can often disclose colonies of fair size.

Ten males and five females, taken August 13 to October 13, and one immature female are from **Grafton, Mt. Carmel, Dubois, Running Lake, Makanda, Fountain Bluff, Grand Tower, Prospect Hill, Goreville, Alto Pass, Aldridge, Golconda.**

M. differentialis (Thomas).—This large common species is probably abundant, particularly in waste weedy areas, throughout Illinois.

Forty-two males and 24 females, taken August 19 to October 1, and seven immature examples are from **Kenilworth, Winnetka, Chicago, Pistakee Bay, Algonquin, Amboy, Savanna, Riverside, Downers Grove, Putnam, St. Anne, Rutland, Peoria, Havana, Hamilton, Urbana, Champaign, Spaulding, Charleston, Nokomis, Hillsboro, Grafton, Alton, Lawrenceville, Billett, Odin, Shawneetown, Grand Tower, Herod, Golconda, Dixon Springs, Cache.**

M. bivittatus (Say).—The great majority of this series have the caudal tibiae rich pink, but a very few have these parts buffy or buffy and bluish black, *viz.*, one from Elliott in a series of 17, one from Champaign, one from Charleston and two from Dubois.

This common species is probably even more generally distributed throughout Illinois than the preceding.

Seventy-four males and 40 females, taken June 18 to August 26, are from **Beach**, **Zion**, **Lake Forest**, **Kenilworth**, **Winnetka**, **Chicago**, **Antioch**, **Sun Lake**, **Volo Lake**, **Algonquin**, **Riverside**, **Downers Grove**, **Moline**, **St. Anne**, **Elliott**, **Havana**, **Homer**, **Urbana**, **Champaign**, **Seymour**, **White Heath**, **Teheran**, **Charleston**, **Mt. Carmel**, **Dubois**, **Carbondale**, **Grand Tower**, **Prospect Hill**, **Golconda**, **Dixon Springs**.

M. punctulatus punctulatus (Scudder).—McNeill recorded this insect from Galesburg and Urbana in 1891, and Scudder reported it from Rock Island in 1897.

The present specimens agree in size with Virginia material before us, being considerably larger than those from Massachusetts and northern New York.

As Urbana is the southernmost known locality in Illinois, we can not tell whether intergradation with *punctulatus arboreus* occurs in the southern portion of the state.

This insect is very local but often moderately numerous in restricted areas and there is found on the trunks of trees. It remains so motionless and blends so completely with its immediate surroundings that it is rarely secured unless special and intensive search is made for it.

Antioch: Aug. 6, 1930, 2♀ on *Larix*, Frison and Knight. **Barrington:** Aug. 15, 1897, 1 large juv.♀. **Oakwood:** Sept. 18, 1927, 1♂, 1♀, *in coitu*, Frison. **Urbana:** Oct. 4, 1885, 1♀; Oct. 14, 1906, 1♂.

M. dawsoni (Scudder).—Lake Forest is a southern limit for this species, not previously known from Illinois. Its range extends from Maine to British Columbia, but its distribution is probably highly discontinuous east of the Mississippi.

Beach: Aug. 21 to 28, 1906 to 1932, 28♂, 30♀. **Zion:** Aug. 25, 1932, 3♀, Ross and Mohr. **Lake Forest:** Sept. 26, 1902, 1♂, 3♀, Hancock.

M. impudicus Scudder.—A northern limit is Forest City. In that vicinity the species is probably confined to sandy areas, but Hart reported it common on the high rocky slopes of the Ozark Ridge in southern Illinois.

Forest City: Aug. 20, 1904, 1♀, Hart and Brown. **Bath:** Aug. 17, 1903, 2♂, 1♀, Hart. **Herod:** Sept. 4, 1932, 1♀, Ross and Horsfall. **Prospect Hill:** June 29, 1905, July 25, 1898 and Aug. 13, 1905, 8♂, 2♀. **Williams Mountain:** Aug. 11, 1905, 1♀, Hart. **Alto Pass:** June 27, 1905, 1♀, Hart. **Dixon Springs:** Oct. 13, 1932, 1♀, Frison and Ross. **Cache:** Oct. 14, 1932, 3♀, Frison and Ross.

M. confusus Scudder.—This species has been recorded from Illinois under the preoccupied name *minor* of Scudder by that author in 1897 and from Devil's Neck near Topeka by Hart in 1907.

The caudal tibiae are dull glaucous in all but eight females of the present series, in which they are pink.

This species appears in grassy spots in the spring and should be found locally throughout Illinois, though the following are the only localities as yet known for the state.

Fifteen males and 16 females, taken June 4 to August 2, all but three in June, are from **Beach, Waukegan, Fox Lake, Devil's Neck** and **Watson** on high prairie.

M. femur-rubrum femur-rubrum (DeGeer).—A series of 334 specimens of this species, ubiquitous in the east, is from all parts of Illinois. Some from Karnak are unusually large. This red legged locust is the commonest and most abundant grasshopper in the state.

M. fasciatus (F. Walker).—Dubois is a southern limital point for this boreal, sylvan insect. In the southern portion of Illinois it is probably present only on or near the Ozark Ridge. Hart reported it as being found in blackjack oak areas in Illinois and it is probably very local in this state.

Forest City: Aug. 20, 1904, 3♂, 8♀, Hart and Brown. **Havana:** July 11, 1912, 1♂ at White Oak Run; Aug. 14, 1907, 1♀ at river shore. **Muncie:** June 30 and July 6, 1907, 30♂, 28♀. **Bluff Springs:** June 10, 1932, 1♀, Ross and Mohr. **Dubois:** June 21, 1905, 1♂, Hart.

M. borealis junius (Dodge).—This race was reported as *extremus*, a synonym of *borealis borealis*, from Chicago by Scudder in 1897. It is the southernmost race of a species whose typical race occupies a very wide area of distribution far to the north. It probably occurs only in restricted bog areas in northern Illinois, Manito being a southern limit.

Chicago: July 11, 1903, 2♂, 2♀, Hancock. **Volo:** July 8, 1932, 1♂, Ross, Dozier and Mohr. **Manito:** June 10, 1914, 1♂.

M. mexicanus mexicanus (Saussure).—One hundred eighteen males and 110 females of this very common race, which for long was recorded as the synonym *atlanis*, are before us from all parts of Illinois. It is apparently usually not as common as *femur-rubrum* in the east, though as a rule very much more abundant than that insect in the west.

In the present series 54 specimens have the caudal tibiae light glaucous, in several they are buffy or partly pale pink and partly pale glaucous, and in the rest they are pink. This is a very much higher percentage having glaucous caudal tibiae than is found on the Atlantic coast.

In 1878 Thomas stated that strays of *spretis* (Thomas) = *spretus* (Walsh), now known to be the migratory phase of *mexicanus*, might have been taken in Illinois. It is possible but not probable that indi-

viduals of that phase reached this far east and without any material from Illinois being known that name should be omitted from a list for the state.

M. keeleri luridus (Dodge).—McNeill (1891) and Scudder (1897) reported this race from Illinois as the synonym *collinus*.

Probably local, this race should be found often fairly abundant in semisylvan environments, in sand areas, on hills and sides of ravines and on natural prairies throughout Illinois.

Fourteen males and 20 females, taken June 26 to September 6, and four immature individuals are from **Beach, Waukegan, Winnetka, Moline, St. Anne, Forest City, Bishop, Bath, Arenzville, Chautauqua, Makanda.**

M. foedus fluviatilis Bruner.—A pair of paratypes of *macneilli* Hart from the sand hills at Moline are in the author's collection. These show that Blatchley (1920) was correct in assigning that name to the present synonymy.

Moline is the only locality known for Illinois, but the race undoubtedly occurs on the river bottomlands in the western portions of the state, as we have seen it from 13 localities in Iowa and also from St. Anthony Park, Minn.

The affinity to *angustipennis* is not as close as Hart supposed, the present insect being distinguished not only by the much shorter and more divergent male furcula and the usually lighter and grayer dorsum in both sexes, but also by the male subgenital plate which terminates in a bluntly rounded apex, whereas in *angustipennis* that plate is broad at its extremity, showing more or less conspicuously two rounded projections.

Very rarely has *angustipennis* the outer ventral surfaces of the caudal tibiae as rich sanguineous as is often the case in the present insect and as is shown by the Illinois material. This coloration is however absent in some series or individuals of *foedus fluviatilis*. It can therefore not be used as a constant feature of difference.

This is the river valley and more eastern race of the very widespread and plastic western species *foedus*.

M. angustipennis (Dodge).—In the Illinois material studied the caudal tibiae are rich pink in 29 males and 20 females, rich glaucous in the others, this latter being the normal condition. Each series is subject to decided individual variation, but the large series from Beach and Waukegan average small and very dark, those from Havana and Fulton very large and pale. A series taken at Topeka in October averages as large but considerably darker and all the markings are dull. Toward the end of the season surviving individuals of many species of grasshoppers are tattered, very dark and dull colored.

In the present material the outer ventral section of the caudal femora is yellowish buff, sometimes more or less strongly tinged with orange, but in four males from Arenzville that area is sanguineous.

This species occurs only in the open on sandy soil in Illinois, but is often very common locally. *Meredosia* is a southeastern limit for *angustipennis*, a species very widespread in the west, but further north it is known as far east as Kewanna in northwestern Indiana.

Eighty-eight males and 79 females, taken June 23 to October 30, and one immature are from **Beach, Zion, Waukegan, Chicago, Oregon, Fulton, Moline, St. Anne, Forest City, Bishop, Topeka, Havana, Bath, Arenzville, Meredosia.**

M. flavidus flavidus Scudder.—McNeill's *cenchri*, described from Moline in 1891, is an established synonym.

Meredosia is a southeastern limit, this race being known as far east as Pine, Ind. Its distribution is discontinuous in Illinois, but it should be found in sand areas throughout the northern portion of the state.

Twenty-nine males and 24 females, taken August 10 to September 9, are from **Beach, Moline** (sand hills), **St. Anne, Bishop, Topeka** (sand prairie), **Havana, Devil's Hole, Bath, Meredosia.**

Dendrotettix Riley

D. quercus Packard.—The accompanying records were given in 1920 by Blatchley and are probably easternmost limits for the species as naturally distributed. Bruner recorded the species from Illinois in 1893a. Though thoroughly established in New Jersey and adjacent New York, we believe that *quercus*, like *Melanoplus differentialis*, was accidentally introduced by man on the Atlantic coast.

These specimens, like others from St. Louis and Willard, Mo., are shorter and stockier with coloration more gray and dorsocaudal bars of femora more conspicuous than Texan material in which the legs show conspicuously red browns and light yellows. Series from southeastern Kansas and the east are almost intermediate but resemble the Texan series more closely. These differences may well be due to local environment.

Though known to appear locally sometimes in enormous numbers, this species is arboreal and usually very difficult to locate except during such outbreaks.

Crete: July 30, 1905, 1 ♂. **Dubois:** June 21, 1905, 1 ♀.

Phoetaliotes Scudder

P. nebrascensis (Thomas).—This species was recorded as the synonym *Pezotettix autumnalis* from Illinois by McNeill in 1891.

Bloomington and Bath are southeastern limits, but the species reaches extreme northwestern Indiana along the shore of Lake Michigan.

It is apparently local but often abundant when found in sand areas in northern Illinois.

Forty-four males and 28 females, taken August 4 to September 28, and six immatures are from **Beach, Waukegan, Volo Lake, Cordova, St. Anne, Bloomington, Forest City, Bishop, Bath**. One male and three females are macropterous, the others brachypterous.

Paroxya Scudder

KEY TO SPECIES

Organs of flight fully developed. Form less elongate. Smaller. Male antennae shorter than caudal femur. Male cerci at apex evenly rounded dorsad and ventrad.

.....**atlantica atlantica**

Organs of flight decidedly reduced. Form more elongate. Larger. Male antennae longer than caudal femur. Male cerci with apex showing a decided rounded projection ventrocaudad.....**hoosieri**

P. atlantica atlantica (Scudder).—This species is known in Illinois and Indiana only from the swamps near the shores and usually in the sand areas bordering Lake Michigan. It would appear very probable that it reached this far northwestward from the east, and not from the south by way of the Mississippi.

Thirty-nine males and 22 females, taken August 3 to September 26, and one immature individual are from **Beach, Waukegan, Lake Forest, Chicago, Channel Lake, Cedar Lake, Sun Lake, Long Lake**.

P. hoosieri Blatchley.—The following is a western limit record and the first for Illinois. The species may however have a fairly extensive distribution in the swamps along the eastern border of the state. It is probably a distinct species and not a race of *clavuliger*, as was indicated by Blatchley in 1920. Morse's record (1907) from Buras, La. is based on material of *hoosieri*.

St. Francisville: Sept. 8, 1933, 1♀, Ross and Mohr.

TETTIGONIIDAE

KEY TO SUBFAMILIES AND GENERA

1. Organs of flight present. Cephalic tibiae with auditory foramina. Ovipositor normal in having dorsal and ventral valves in that position throughout. .2
- Organs of flight absent. Cephalic tibiae lacking auditory foramina. Ovipositor very elongate, very slender vertically and horizontally, with dorsal valves including the ventral valves throughout.....12
2. Prosternum unarmed. Cephalic tibiae with auditory foramina without a lateral slit. General coloration green. Ovipositor elongate and deep but transversely very greatly compressed, lamellate (*PHANEROPTERINAE*, p. 203).....3

TETTIGONIIDAE—KEY TO SUBFAMILIES AND GENERA—CONT'D

- Prosternum armed with a pair of spines usually elongate except in species of *Atlanticus*, and erect except in *Conocephalus saltans*. Cephalic tibiae with auditory foramina having a long lateral slit.....7
3. Fastigium little if at all wider than proximal antennal segment, horizontal or but little deflexed, fig. 105. Tegmina long and narrow in comparison with alternate category, very little broader mesad than distad, except in *Scuddereria pistillata* which has the tegmina decidedly broad but narrowing little distad. Male subgenital plate without socketed styles, except in *Montezumina modesta* which sometimes has traces of sockets at the bases of the styliform appendages.....4
- Fastigium very wide, fig. 110, curving downward to facial fastigium. Tegmina very broad, distinctly broader mesad than distad. Male subgenital plate with socketed styles.....6
4. Proximal branch of median vein, which springs from the discoidal vein mesad, not joining the ulnar vein, fig. 97. Tegmina broader than in alternate category. General coloration immaculate green.....5
- Proximal branch of median vein joining the ulnar vein for a short distance, fig. 98. Tegmina very narrow for this subfamily. General coloration green, strikingly marked with brown and black. Male ultimate tergite not produced. Male cerci short, incurved, with apex enlarged. Male subgenital plate elongate, expanding at apex. Ovipositor shorter and showing angulation of the dorsal margin in its stronger curvature dorsad. Peculiar to cypress swamps.....**Inscuddereria**, p. 205
5. Cephalic and median femora with ventral margins unarmed. Eyes subglobose. Margins of pronotal disk less sharply defined. Larger. Male subgenital plate lacking definite styliform processes.....**Scuddereria**, p. 203
- Cephalic and median femora with ventrocephalic margins strongly dentate and moderately lamellate. Eyes oblong-oval, much deeper than wide. Margins of pronotal disk sharply defined. Small. Male ultimate tergite with a large produced area curving downward and no longer than wide. Male cerci long and gently curved, bent suddenly inward but not enlarged at apex. Male subgenital plate briefly produced, with very small styliform processes and traces of sockets sometimes indicated. Ovipositor curved dorsad with angulation scarcely indicated. Prefers bush foliage in forests.....**Montezumina**, p. 205
6. Cephalic and median tibiae flat or sulcate dorsad, with margins raised. Tegmina oblong-elliptical or ovate. Caudal femora elongate. Ovipositor large and elongate, curving dorsad, with margins convex-convergent to the acute apex.....**Amblycorypha**, p. 206
- Cephalic and median tibiae convex dorsad. Tegmina ovate-lanceolate. Caudal femora short. Ovipositor extremely small, with distal extremity of ventral valves showing truncation. Arboreal species.....**Microcentrum**, p. 207
7. Pronotum as broad as long. Pronotal disk crossed by two transverse sulci. Form extremely robust. Large. Tegmina short and very broad, with dorsal surface decidedly convex and male stridulating area very highly developed with heavy veins. Green, with stridulating field of male brown. Very small vertex acute, produced. Strictly arboreal. (**PSEUDOPHYLLINAE**).....**Pterophylla**, p. 208

TETTIGONIIDAE—KEY TO SUBFAMILIES AND GENERA—CONCL'D

- Fastigium not or scarcely sulcate, subconical to subplanate. Tarsal claws lacking basal sensory setae. Male subgenital plate lacking styles. Ventral valves of ovipositor conspicuously toothed.....16
14. Halves of fastigium low, rounded. Genicular lobes of cephalic and middle femur unarmed. Dorsal carinae of caudal tibia with some movable spurs. Caudal metatarsus unarmed distodorsad.....**Hadenoeus**, p. 222
- Halves of fastigium acute-conical. Genicular lobes of middle femur and caudal lobe of cephalic femur with movable spurs. Dorsal carinae of caudal tibia with fixed denticulations only, except at apex. Caudal metatarsus terminating in a distodorsal spine.....15
15. Dorsal carinae of caudal tibia armed with distinctly separated, subequal denticulations. Small median spur present between paired distoventral spurs of cephalic tibia. Ventral keel of cephalic metatarsus not setose. Unicolorous.....**Diestrammena**, p. 220
- Dorsal carinae of caudal tibia armed with crowded denticulations arranged in groups within which spine size increases distad, this series interrupted at about distal fourth of tibia by a pair of larger, opposite spines. No median spur between distoventral spurs of cephalic tibia. Ventral keel of cephalic metatarsus with row of stout setae extending nearly to apex. Variegated.....**Tachycines**, p. 221
16. All tarsi four segmented. Elevated margins of antennal fossae with bases touching or nearly so. Genicular spur present on caudal face of middle femur.....17
- Cephalic tarsus three segmented, others four segmented, proximal two segments of caudal tarsus showing incipient fusion. Elevated margins of antennal fossae with bases separated mesad by space at least equal to middle breadth of antenna. Middle femur without genicular spur. Very robust. Caudal legs of male highly modified; tibia shorter than femur in both sexes; each dorsal carina with five spurs (seven in certain allied genera). Ovipositor short, stout; dorsal valves abruptly truncate at apex.....**Phrixocnemis**, p. 242
17. Dorsal surface of cephalic tibia unarmed except at apex. Coloration not solidly reddish brown to black.....**Ceuthophilus**, p. 222
- Dorsal surface of cephalic tibia with a spur slightly distad of middle of cephalic margin. Reddish brown to black. Robust. Heavily sclerotized. Legs short. All tibiae heavily armed.....**Udeopsylla**, p. 242

PHANEROPTERINAE

Scudderia Stal

KEY TO SPECIES

1. Male ultimate tergite not produced in an elongate median process. Male cerci long and gently curved, with apex not enlarged. Elongate male subgenital plate not compressed distad. Ovipositor longer and more evenly and broadly curved dorsad. Medium size. Tegmina moderately broad for genus. Arboreal.....**septentrionalis**, p. 204
- Male ultimate tergite produced in an elongate median process. Male cerci shorter and very strongly incurved distad, with apex enlarged. Elongate male

SCUDDERIA—KEY TO SPECIES—CONT'D

- subgenital plate compressed distad. Ovipositor shorter and showing angulation of the dorsal margin in its stronger curvature dorsad.....2
2. Male with production of ultimate tergite furcate at apex, with no median projection.....3
- Male with production of ultimate tergite having a slight median projection at apex and with strongly compressed lateral flanges. Size and tegmina as in *curvicauda curvicauda*, females scarcely distinguishable from that species but ovipositor sometimes slightly narrower distad. Prefers swamps and marshes.....**texensis**, p. 205
3. Male with lobes of furcate apex of ultimate tergite bearing ventrad small longitudinal flanges.....4
- Male with lobes of furcate apex of ultimate tergite lacking flanges. Small. Tegmina moderately elongate for genus. Generally distributed. **furcata furcata**, p. 205
4. Tegmina very broad and short for genus, not more than four times as long as wide. Medium size. Male with lobes of furcate apex of ultimate tergite distinctly tapering when seen from above. Prefers bushes in open....
-**pistillata**, p. 204
- Tegmina narrower and longer, at least nearly five times as long as wide. Larger. Male with lobes of furcate apex of ultimate tergite subequal in width when seen from above. Partial to oaks and usually in undergrowth.....
-**curvicauda curvicauda**, p. 204

S. septentrionalis (Serville).—Champaign and Urbana constitute the southern limit of distribution for this comparatively very scarce species. It was previously unknown from Illinois, though it had been reported from Lone Rock, Wis., just over the northern boundary.

Algonquin: July 27 to Aug. 16, 1907 and 1910, 3 ♂. **Cook county:** 1 ♂, Chope, *FM*. **Urbana:** July 19, 1890, 1 ♂ at light in woods, Hart and Shiga; Aug. 15, 1882, 1 ♂ at light, Hart. **Champaign:** July 12, 1887, 1 ♂ at light, Hart.

S. pistillata Brunner.—This boreal species is probably largely confined to bogs in northern Indiana and Illinois.

Scudder's record (1898) from southern Illinois is certainly in error. The same is true of Saussure and Pictet's record (1897) from Georgia unless the material came from the very restricted boreal area in the mountains of the northeastern section. The southernmost definite Appalachian record is Monterey, Va.

Antioch: Aug. 14, 1906, 1 ♀ in tamarack bog. **Cedar Lake:** Aug. 7, 1906, 1 ♂ in bog. **Wauconda:** Aug. 23, 1932, 1 ♀, Ross and Mohr. **Normal:** June 25, 1880, 1 ♀. **Sun Lake:** Aug. 3, 1906, 1 ♂, 3 ♀, in bog.

S. curvicauda curvicauda (DeGeer).—Though more common in the southern portion of the state, this insect undoubtedly occurs over all of Illinois. A specimen showing a northern limit in this longitude is from Lone Rock, just across the line in Wisconsin.

The species has been very frequently confused with the much com-

moner *texensis*. We believe that *curvicauda* is decidedly partial to oak shoots and oak trees.

Amboy: Aug. 25, 1933, 1 ♂, Ross and Mohr. **Devil's Hole:** Aug. 18, 1904, 1 ♀, Hart and Brown. **Nokomis:** Sept. 7, 1932, 1 ♀, Ross and Mohr. **Clay City:** Aug. 21, 1905, 4 ♀. **Dubois:** July 27, 1905, 1 ♂; Aug. 24, 1905, 1 ♂. **Harrisburg:** June 30, 1905, 1 juv. ♂. **Carbondale:** July 16, 1909, 1 ♂. **Fountain Bluff:** July 25, 1905, 1 ♂. **Williams Mountain:** Aug. 11, 1905, 1 ♀. **Dixon Springs:** Sept. 5, 1932, 1 ♀, Ross and Horsfall.

S. texensis Saussure and Pictet.—This was probably the insect recorded as *curvicauda* from Moline by McNeill in 1891. It was reported correctly from Havana by Hart in 1907 and Vestal in 1913.

It is common throughout the state and is probably, as is elsewhere the case, particularly abundant in wet meadows and marshy spots.

Twenty-five males, 23 females, taken July 18 to October 12, and three immatures are from **Beach, Waukegan, Evanston, Antioch, Lake Villa, Sun Lake, Long Lake, Wauconda, Algonquin, Savanna, Fulton, Summit, Oak Lawn, Starved Rock, St. Anne, Normal, Forest City, Havana, Mayview, Urbana, Champaign, Charleston, Shawneetown, Carbondale.**

S. furcata furcata Brunner.—This common race was recorded as *fuscata* by McNeill in 1891.

Sixty-one males and 48 females, taken August 10 to October 15, are from **Beach, Waukegan, Kenilworth, Evanston, Cedar Lake, Wauconda, Algonquin, Amboy, Summit, Putnam, St. Anne, Benson, Normal, Bloomington, Forest City, Havana, Danville, Muncie, Homer, Urbana, Champaign, Mahomet, Monticello, Quincy, Borton, Manchester, Hillsboro, Lawrenceville, Olney, Centralia, Dubois, Shawneetown, Carbondale, Herod, Golconda, Dixon Springs, Metropolis, Karnak, Ullin, Cache, Thebes.**

Inscudderia Caudell

I. taxodii Caudell.—This delicate and distinctive katydid was described by Caudell in 1921 and figured in color by the author in 1925b. The present records extend the known distribution of the species considerably northward, as it was previously not known north of Greenville, Miss.

Karnak: July 26, 1930, 1 ♀, 2 juv. ♂, 3 very small juv., on *Taxodium distichum*, Knight and Ross. **Cairo:** July 27, 1930, 1 ♂, 2 small juv., on *Taxodium distichum*, Knight and Ross.

Montezumina Hebard

M. modesta (Brunner).—In 1878 Brunner proposed the genus *Symmetropleura*, including three species, each probably representing a distinct genus, of which the South American *laevicauda* was selected as genotype by Kirby in 1906. Brunner in the same study described *Turpilia oblongoculata* and using that species as genotype we erected the genus *Montezumina* (Hebard, 1925c), there explaining its affinity

to *Anaulacomera* rather than to *Turpilia* and *Diplophyllus*, as had been supposed. We have long realized that *Symmetropleura* was a composite genus, but not until the present was it realized that *modesta* was a species not only referable to *Montezumina* but exceedingly closely related to the Mexican *oblongoculata*. Indeed *modesta* is practically inseparable in the male sex but the female has an ovipositor which is much larger, less bent and distally broader, nearer the type developed in *Montezumina sinaloae* Hebard, but more definitely rounding to its apex.

In 1920 Blatchley recorded a female belonging to the Field Museum as *Symmetropleura modesta* from Boskydell near Carbondale. Previously the species had been recorded only as far west as Mississippi. On the Atlantic coast it has been found as far north as Raleigh, N. C. It is probable that the species is limited in its distribution within the state to the extreme southern part.

Cairo: July 27, 1930, 1♀, Knight and Ross.

Amblycorypha Stal

KEY TO SPECIES

1. Lateral lobes of pronotum with humeral sinus decided, fig. 113, rounded and forming approximately a right angle. Caudal margin of disk of pronotum convex. Tegmina proportionately narrower. Form less robust.....2
- Lateral lobes of pronotum with humeral sinus weak, fig. 114, rounded obtuse-angulate. Caudal margin of disk of pronotum more broadly convex. Tegmina proportionately broader. Form slightly more robust. Medium size. Caudal femora normal for genus. Male subgenital plate with distal margin V-emarginate.....**rotundifolia rotundifolia**, p. 207
2. Male subgenital plate with distal margin V-emarginate. Ovipositor not deeper distad than at base. Large. Caudal femora proportionately less elongate.**oblongifolia**, p. 206
- Male subgenital plate with distal margin truncate or very feebly obtuse-angulate emarginate. Small for genus. Ovipositor deeper distad than at base. Caudal femora elongate for genus.....**uhleri**, p. 206

A. oblongifolia (DeGeer).—Generally distributed over Illinois, this species has been repeatedly recorded from the state correctly.

Twenty males and 15 females, taken July 28 to September 9, are from Beach, Winnetka, Kenilworth, Wilmette (a purplish pink female, *FM*), Evanston, Chicago, Antioch, Moline, Kankakee, Danville, Urbana, Norris City, Grand Tower, Pulaski, Thebes.

A. uhleri Stal.—Recorded from Meredosia by Hart in 1907, the species is now known to occur over southern Illinois as far north as this locality, which also constitutes a western limit point. We have recently noted that the species does not occur in Minnesota, the following Illinois localities being in the latitude of northernmost advance of *uhleri*.

Eleven males, six females and one immature male, taken July 27 to

September 2, are from Meredosia, Grafton, Clay City, Centralia, Dubois, Herod, Prospect Hill, Williams Mountain, Elizabethtown, Metropolis.

A. rotundifolia rotundifolia (Scudder).—Though Winnetka, Amboy and Moline (Rehn and Hebard 1914) are known northern limits, all of Illinois is probably included in the distribution of this race.

Fifteen males and 16 females, taken June 21 to October 6, are from Winnetka, Amboy, Riverside, Willow Springs, Palos Park, Moline, Havana, Hilliary, Muncie, St. Joseph, Urbana, Champaign, Seymour, Charleston, Odin, Dubois, Murphysboro, Fountain Bluff, Prospect Hill, Dixon Springs.



Fig. 158.—Adult male of the bush katydid *Microcentrum rhombifolium* (Saussure). $\times 1.6$.

Microcentrum Scudder

KEY TO SPECIES

- Pronotum with cephalic margin showing a distinct though weak angulate production mesad. Very large. Fastigium weakly sulcate. Stridulating area of male tegmina immaculate. Male cerci gently incurved, apex not thickened, armed with a minute tooth beside the immediate tip. Male styles smaller and shorter, separated by a broad concave interval. Ovipositor with apex of ventral valves transverse truncate. ***rhombifolium***, p. 207
- Pronotum with cephalic margin evenly concave. Large. Fastigium distinctly sulcate. Stridulating area of male tegmina with a large brown suffusion. Male cerci bisinuate, apex moderately enlarged, a minute but stout tooth directed sharply inward and inset so that the immediate apex appears bilobate. Male styles large and elongate, separated by a very small but decided emargination. Ovipositor with apex of ventral valves obliquely truncate. . . . ***retinerve***, p. 208

M. rhombifolium (Saussure).—Though in this latitude a northern known limit is Twin Grove, the species undoubtedly occurs throughout the state, as it is known from as far north as Lansing, Mich. and Winona, Minn. We believe however that *rhombifolium* is very scarce throughout northern Illinois. McNeill in 1891 noted that he had never heard or seen the species at Moline, referring to it as *laurifolium*, an error then in general practice.

Thirteen males, 20 females, taken August 10 to October 20, and one immature are from Normal, Twin Grove, Urbana, Champaign, Mahomet, Charleston, Metropolis, Olive Branch.

M. retinerve (Burmeister).—The present record is a northwestern limit, the species being known in Indiana only as far north as Vigo county. Other western limits are shown by other specimens before us to be Polk county on the central portion of the western boundary of Arkansas, and Bowie county in extreme northeastern Texas. We believe Bruner's records (1893b) from Nebraska and Kansas are incorrect, no material from those states being in his collection nor has any been subsequently secured there. The records from New Mexico, Arizona and Central America are, we now know, based on material of allied but distinct species.

Jonesboro: Aug. 28, 1889, 1♂, Hart.

PSEUDOPHYLLINAE

Pterophylla Kirby

P. camellifolia (Fabricius).—Occurring over all of Illinois, this species was recorded as the synonym *Cyrtophyllus concavus* by McNeill in 1901.

Thirteen males and 20 females, taken July 23 to October 27, and one immature are from **Winnetka, Kenilworth, Evanston, Downers Grove, Waterman, Willow Springs, Palos Park, Lake Senachwine** at Putnam, Oakwood, Urbana, Kansas, Charleston, Dubois, Alto Pass, Golconda.

COPIPHORINAE

Neoconocephalus Karney

KEY TO SPECIES

1. Fastigium with length approximating width, fig. 121, its ventral surface dark or with a dark band.....2
Fastigium decidedly longer than wide, fig. 123.....3
2. Fastigium large and usually slightly wider than long, fig. 120. Ovipositor approximately length of caudal femur. Form robust for genus. Large....
.....**triops**, p. 209
Fastigium small and usually slightly longer than wide, fig. 121. Ovipositor very much longer than caudal femur. Form more slender. Medium to small for genus.....**retusus**, p. 209
3. Fastigium moderately produced for genus, distinctly longer than proximal width, figs. 122, 127.....4
Fastigium strongly produced, much longer than basal width, figs. 126, 128....6
4. Fastigium narrowing to the more acute apex, fig. 127, with ventral surface immaculate. Male small and slender, female larger and robust with abdomen decidedly enlarged. Pronotum elongate, expanding evenly caudad. Ovipositor wider than usual for genus, normally slightly shorter than caudal femur. Swamp inhabitant.....**palustris**, p. 209
Fastigium with apex broader, fig. 123. Male large, female larger. Pronotum not elongate, not expanding evenly caudad. Ovipositor of normal width, slightly shorter (normal) to slightly longer than caudal femur. Ventral

NEOCONOCEPHALUS—KEY TO SPECIES—CONT'D

- surface normally immaculate, rarely with a very small distal suffusion.
Form robust for genus.....5
5. Fastigium shorter, not narrowing as decidedly and with apex somewhat broader, fig. 122. Large to (normally) very large.....**robustus robustus**, p. 210
Fastigium longer, narrowing decidedly and with apex sharply rounded, fig. 123. Large.....**robustus crepitans**, p. 209
6. Fastigium with ventral surface narrowly but continuously margined laterad and distad with black; slender and elongate, fig. 126. Ovipositor much longer than caudal femur.....**ensiger**, p. 210
Fastigium with ventral surface black to or including basal tooth; heavy or very elongate, figs. 129, 130.....7
7. Fastigium not as long, with basal tooth less prominent, fig. 116. Ovipositor much longer than caudal femur. Medium size.....8
Fastigium exceedingly long, with basal tooth very prominent, fig. 117. Ovipositor very much longer than caudal femur. Medium to very large....
.....**exiliscanorus**, p. 211
8. Fastigium pointed, its sides straight or concave, fig. 128.....**lyristes**, p. 211
Fastigium broadly rounded, not pointed, its sides more or less convex, fig. 129.....**nebrascensis**, p. 210

N. triops (Linnaeus).—This is a northern limit and the first record of *triops* from the state. The species is probably confined to southern Illinois.

Cairo: May 23, 1927, 1♂, brown, attracted to light.

N. retusus (Scudder).—Not previously known from Illinois, this species includes the southern portions of this state and Indiana in its distribution. Urbana is a northern limit point.

Urbana: Aug. 29, 1909, 1♀, green. **Lawrenceville:** Sept. 7, 1933, 2♂, 1♀, 1♂ brown, pair green, Ross and Mohr. **Clay City:** Sept. 2, 1909, 1♂, brown. **Dixon Springs:** Sept. 5, 1932, 1♀, green, Ross and Horsfall. **Dongola:** Aug. 23, 1916, 1♀, green. **Ullin:** Sept. 20, 1932, 1♀, green, Frison and Mohr. **Olive Branch:** Oct. 29, 1909, 1♀, Gerhard, *FM*.

N. palustris (Blatchley).—Lawrenceville and Carbondale are northern and western limits respectively for *palustris*, a species living in swamps and consequently much less frequently encountered than the ubiquitous forms of the genus. It is probably confined to the southern portions of Indiana and Illinois.

Lawrenceville: Sept. 7, 1933, 1♀, green, Ross and Mohr. **Carbondale:** Aug. 4, 1909, 1♀, green, at light.

N. robustus crepitans Scudder.—The Cairo female alone is strictly typical of this poorly defined race, being larger with vertex blunter than the others, which show individual variation in these features. In none of the present series is there a small dark marking on the ventral surface of the vertex.

At present Urbana is a northern limit point in this longitude. The race may occur over the entire state, but it is probably very scarce in the northern portions.

Urbana: 1♂, green. **Jacksonville:** Aug. 7, 1903, 1♂, green, Crane. **Clay City:** Aug. 22, 1905, 1♂, green; Sept. 2, 1909, 1♂, green. **Dubois:** July 27, 1905, 1♀, brown. **Cairo:** Aug. 1, 1905, 1♂, green.

N. robustus robustus (Scudder).—The present individuals are somewhat atypical, the vertex averaging appreciably less produced than in series from the Atlantic coast. In all other respects however close agreement is found and individuals showing nearest convergence can certainly not be separated even racially. It is evident that this is the insect which Blatchley (1920) recorded from the shores of Lake Michigan in La Porte county, Ind. It is becoming increasingly apparent that this insect may be the response to a sand environment in this species and not the typical race elsewhere represented by a separable geographic race (*robustus crepitans*). We do not yet feel justified, however, in indicating synonymy.

The present insect probably occurs in sandy areas throughout Illinois.

Forest City: Aug. 20, 1904, 1♀, green, Hart and Brown. **Topeka:** Aug. 7, 1908, 2♂, 1 green, 1 brown, Ewing. **Devil's Hole:** Aug. 12 to Sept. 11, 1904 to 1910, 5♂, 2♀, 1♂ brown, others green. **Quiver Lake:** Aug. 11, 1884, 1♂, brown, on shore, Hart. **Anna:** Aug. 5, 1883, 1♂, brown.

N. ensiger (Harris).—The last three localities are limit points in the distribution southward of this species.

Sixteen males, 22 females, taken July 23 to September 1, and four immatures are from **Beach, Chicago, Algonquin, Ottawa, Urbana, Champaign, Seymour**. The great majority are green, a very few specimens being light brown.

N. nebrascensis (Bruner).—In this series the ventral surface of the vertex is black with the exception of the basal portion including the tooth which is of the ground coloration (brown or green). Only in the Muncie male is the ventral surface of the vertex almost solidly black, showing very weak paling only at the base of the tooth.

We have recently expressed the opinion that Lugger's record (1897) of this species from Minnesota was an error, though *nebrascensis* may indeed occur in the southern portion of that state. All of Illinois is probably within its range, though Moline is as yet a northernmost and Charleston a southernmost known point in this longitude. Blatchley recorded much of the present material in 1920. With it he included a female of *lyristes* from Normal.

Moline: Aug. 25, 1♂, green, McNeill; Sept. 12, 1♂, paratype, green, McNeill, HC. **Normal:** Aug. 16, 1879, 1♀. **Muncie:** July 28, 1909, 1♂,

green, vertex slightly longer than normal. **Homer:** Sept. 2, 1905, 1♀, green, vertex slightly longer than in allotype from Omaha, Neb., *HC*. **Urbana:** July 15 to Aug. 13, 1885 and 1887, 1♂, 2♀, pair brown, 1♀ green. **Charleston:** Aug. 20, 1910, 1♀, brown, vertex slightly longer than normal.

N. lyristes (Rehn and Hebard).—Close affinity to *nebrascensis* is shown by this insect, but we can find no justification in placing it as a race of that species, as was done by Blatchley in 1920.

Ohio and Illinois series show that two distinct species exist in this region and *lyristes* is seen to extend its distribution far west of the Atlantic coast, to which we have believed that it was limited. It is probable that the present species reaches its northwestern limits of distribution along the shores of Lake Michigan in northeastern Illinois.

Beach: Aug. 21 and 24, 1906, 1♂, 2♀, very small, pale brown, in swamps and on sand ridges. **Chicago:** Sept. 17, 1905, 2♂, green, south of Jackson Park on *Iris versicolor*, Hancock, *HC*. **Savanna:** Sept. 6, 1905, 1♀, recorded as *nebrascensis* by Blatchley in 1920. **Palos Park:** Sept. 5, 1909, 1♀, brown, Smith.

N. exiliscanorus (Davis).—This large and handsome species has been very rarely encountered except on the Atlantic coast from Long Island to Virginia. The following is a northwestern limit record, a northern limit point being New Harmony, Ind., a specimen from there constituting the basis for Blatchley's synonym *bruneri*. A western limit point is Dallas, Tex.

Tower Hill: Aug. 1933, a considerable colony located by Hunter, *HC*.

CONOCEPHALINAE

Orchelimum Serville

KEY TO SPECIES

1. Male cerci of moderate length, with portion beyond tooth little if any longer than portion before it, fig. 141.....2
Male cerci more elongate, with portion beyond tooth distinctly longer than portion before it, fig. 140. More slender species.....5
2. Male cerci with tooth much longer than distal portion of shaft; distal portion simple, conical, fig. 133. Lateral lobes of pronotum with humeral sinus broad and shallow. Caudal femora with outer ventral angle always spined....
.....*silvaticum*, p. 213
Male cerci with tooth not longer than distal portion of shaft; distal portion bearing a node or carina, fig. 138. Caudal femora with ventral margins unarmed (occasionally with one or two spines).....3
3. Tibiae not darkened. Male cerci with a large dorsal node (but no arina) mesodistad, fig. 138. Ovipositor shorter, never distinctly over half as long as caudal femur. Form more robust. Moderately macropterous and (rarer) strongly macropterous phases developed.....4
All tibiae black or partially suffused. Male cerci dorsad with a distinct, obtuse,

ORCHELIMUM—KEY TO SPECIES—CONT'D

- sinuate carina, but lacking a node, fig. 134, with tooth strongly apressed against proximal portion of carina. Ovipositor longer, distinctly over half as long as caudal femur. Lateral lobes of pronotum with little indication of humeral sinus and remainder of caudal margin distinctly sinuate. Caudal femora with ventral margins armed. Form moderately graceful. Occurs only in proximity of water.....**nigripes**, p. 214
4. Lateral lobes of pronotum with humeral sinus distinct, fig. 108. Male cerci with apical portion of shaft longer than tooth and its apex blunt, fig. 138. Ovipositor curved evenly dorsad and only slightly broader mesad than elsewhere.....**vulgare**, p. 212
- Lateral lobes of pronotum with humeral sinus broad and shallow, fig. 109. Male cerci with apical portion of shaft equal in length to tooth and its apex sharper. Ovipositor with dorsal margin straight beyond base, strikingly broader mesad than elsewhere.....**gladiator**, p. 213
5. Male cerci with a distinct, obtuse sinuate carina, fig. 140. Tibiae not black. Lateral lobes of pronotum with humeral sinus appreciable, and remainder of caudal margin weakly convex. Caudal femora with ventral margins unarmed, occasionally with one or two spines. Form medium for genus. Marsh inhabitant.....**bullatum**, p. 214
- Male cerci without a distinct dorsal carina.....6
6. Antennae not annulate. Lateral lobes of pronotum deeper. Caudal femora with ventral margins rarely armed. Male with speculum of stridulating field of tegmina only weakly longitudinal. Male cerci with tooth nearly median in position (in vertical sense); apex of cerci not decidedly acuminate. Ovipositor with depth not conspicuously greatest mesad.....7
- Antennae very finely annulate. Lateral lobes of pronotum not as deep. Caudal femora with ventral margins spined. Male with speculum of stridulating field of tegmina decidedly longitudinal. Male cerci with tooth dorsal (in vertical sense); apex of cerci decidedly acuminate. Ovipositor with depth conspicuously greatest mesad. Marsh inhabitant.....**volantum**, p. 215
7. Ovipositor never more than slightly over half as long as caudal femur, slender and showing stronger curvature dorsad. Face sometimes with a very striking vertical dark marking. Eastern race....**concinnum concinnum** p. 214
- Ovipositor considerably to very decidedly over half as long as caudal femur, heavier and showing weaker curvature dorsad. Western race.....**concinnum delicatum**, p. 214

O. vulgare Harris.—This very common and generally distributed, weed loving species has been recorded from Illinois correctly, but individuals at hand with organs of flight showing extreme caudation have been recorded improperly as *glaberrimum* and *longipenne*. Fourteen males and 13 females of the present series show that condition and a number of other specimens are intermediate between it and the normal.

Ninety-one males and 61 females, taken July 24 to October 14, are from Beach, Winnetka, Kenilworth, Lake Villa, Sun Lake, Volo, Wauconda, Algonquin, Amboy, Downers Grove, Watertown, Moline, St. Anne, Forest City, Bishop, Devil's Hole, Muncie, St. Joseph, Urbana, Champaign,

Mansfield, Arcola, Charleston, Nokomis, Lawrenceville, Billett, Alma, Odin, Norris City, Ashley, Dubois, Tamaroa, Shawneetown, Marion, Makanda, Herod, Alto Pass, Golconda, Dixon Springs, Vienna, Cache.

O. gladiator (Bruner).—This boreal species is confined to central and northern Illinois, Champaign being a southern limit of distribution.

Sixteen males and 12 females are from **Beach** (in swamp), **Waukegan**, **Chicago**, **Antioch**, **Cedar Lake** (in bog), **Sun Lake** (in bog), **Wauconda**, **Algonquin**, Champaign.

O. silvaticum McNeill.

1891 *Orchelimum silvaticum* McNeill, Psyche, vol. 6, p. 26. ♂, ♀, Rock Island, Ill.

1915 *Orchelimum calcaratum* Rehn and Hebard, Trans. Am. Ent. Soc., vol. 41, p. 46, figs. 1, 2, 43, 44 and 73. ♂, ♀, type locality San Antonio, Tex.

Rehn and Hebard (1915a) placed *silvaticum*, the type of which has been lost, as a synonym of *agile*. Study of series subsequently obtained shows *agile* to be a species which is distributed westward only along the gulf coast north to Chattanooga, Tenn., Montgomery and Selma, Ala., and a narrow strip in Mississippi, Louisiana and Texas, to Harris county in the southeastern portion of the latter state. The present species, on the other hand, is found to occur south to San Antonio, Victoria and Doucette, Tex., and Beauregard county in southwestern Louisiana. Other eastern limits are Clarksville, Tenn. and Ohio (material before us), while northern limits are the latter, Marshall county, Ind. (by inference—recorded as *agile* by Blatchley in 1920), Amboy and Rock Island, Ill., Iowa, (a male in the author's collection) and Capa, S. D.

From study of the Illinois material now available it is evident that *silvaticum* is a valid species, with *calcaratum* of Rehn and Hebard a synonym. Blatchley in 1920 recorded this insect as *calcaratum* from Olney, Ill. and Clarksville, Tenn.

Though McNeill's description is exceedingly unsatisfactory, he states that in *silvaticum* the males have the wings not surpassing the tegmina and the females with ovipositor more than half as long as the caudal femur. In our series both sexes have the tegmina very slightly exceeded by the wings, the ovipositor in Texan series very slightly less than, but in Illinois specimens very slightly more than, half the length of the caudal femur.

In *agile* normally the wings well surpass the tegmina in both sexes, while the ovipositor is considerably less than half as long as the caudal femur. These two species agree, and differ from *vulgare* in having the ventral margins of the caudal femora armed; *silvaticum* resembles *vulgare* much the more closely but has the fastigium narrower.

Amboy: Aug. 25, 1933, 1 ♂, Ross and Mohr. **Devil's Hole**: Aug. 7, 1908, 1 ♀; Aug. 12, 1907, 1 ♂, HC. **Charleston**: Aug. 16 and 17, 1910, 2 ♂ in forest. **Tower Hill**: Aug. 1933, 1 ♂ on oak sprout in upland pasture, Hunter,

HC. Grafton: Aug. 26, 1905, 1♂; Sept. 8, 1932, 1♀, Ross and Mohr. **Olney:** 1♂, 1♀, Ridgway. **Fountain Bluff:** July 25, 1905, 1♂. **Dixon Springs:** Sept. 5, 1932, 1♂, Ross and Horsfall.

O. bullatum Rehn and Hebard.—As this species has been recorded from an upland cattail marsh near Lafayette in northwestern central Indiana by Rehn as a variety of *nigripes* (Fox 1915) and as *bullatum* by Blatchley in 1920, it is certain to be found in similar environment in southern Illinois. The Indiana record is a northeastern limit one for the species. Specimens from Fox's series are in the author's collection.

The species is otherwise known only from southern Louisiana and eastern Texas, but undoubtedly occurs widely through the Mississippi valley south of central Illinois.

O. nigripes Scudder.—A species of the water's edge, this insect is apparently very common in southern Illinois, becoming less numerous northward. In this longitude Algonquin, Ill. and Lone Rock, Wis. are northern limit points.

Fifty-three males, 34 females, taken July 27 to October 25, and four immatures are from Algonquin, Amboy, Savanna, Putnam, Watertown, Havana, Danville, Muncie, Oakwood, Urbana, Monticello, Decatur, Grafton, Alton, New Haven, Shawneetown, Ware, Golconda, Metropolis, Karnak, Cairo.

O. concinnum concinnum Scudder.—We placed Blatchley's *campestre* as a synonym in 1915 and are convinced that that is the correct assignment. Blatchley placed *campestre* as a trinomial in 1920, though discussing it there as a "form" preferring upland pastures and dryer prairies.

In this series 32 specimens have a heavy vertical red-brown stripe on the face, these in almost all cases having been taken in company with individuals with immaculate faces. This color phase is largely confined to the swamps and bogs of northern Illinois and Indiana, a single female being from Clay City to the south. This is a physiological condition like the brown and green color phases of certain species. A large immature of *concinnum* from Ventnor, N. J. was kept alive by us. Its face was immaculate but after its last moult when hardening into an adult a heavy red-brown vertical stripe gradually appeared on its face.

Forty-six males and 50 females, taken August 3 to September 26, are from Beach, Waukegan (swamps), Lake Forest, Winnetka, Chicago (76th street meadows), Channel Lake (swamp), Lake Villa (swamp), Cedar Lake (bog), Sun Lake (bog), Deep Lake, Grays Lake, Volo (tamarack bog), Algonquin, Amboy, Savanna, Glen Ellyn, Havana, Urbana, Quincy, Billett, Clay City, Marion, Anna.

O. concinnum delicatum Bruner.—Under *concinnum delicatum* only females are here recorded, except in one series where the sexes are

definitely associated. We are still unable to separate males of this western race from those of *concinnum concinnum*.

Though typical *concinnum* occurs over the east and the present insect over the great plains, the two conditions, indistinguishable in the male sex and only separable in females by the form and length of the ovipositor, do not appear to have an area of intergradation of the kind usually found between geographic races. Instead, from Indiana to eastern Nebraska and Kansas, typical *concinnum* is strongly dominant but occasionally females representing *concinnum delicatum* are found. Possibly they come from plainslike areas. In South Dakota and western Minnesota, however, *concinnum delicatum* alone has been found.

Beach: Aug. 24 to 26, 1932, 9♂, 7♀, length of ovipositor 9.1 mm. to 10.8 mm., Ross and Mohr. **Algonquin:** July 25, 1905, 3♀, length of ovipositor 10.6 mm. to 10.8 mm., Nason. **Havana:** July 26, 1910, 1♀, length of ovipositor 12.7 mm. **Urbana:** July 30, 1891 and Sept. 1, 1889, 2♀, length of ovipositor 10.8 mm. and 11 mm., 1 at sugar bait in orchard. **Champaign:** Sept. 10, 1891, 1♀, length of ovipositor 10.9 mm., Marten.

O. volantum McNeill.—We have pointed out (Hebard 1931) that a Kansas specimen of *concinnum delicatum* had been in error recorded as this species. Thus *volantum* is known to occur only from southern Ontario (Sarnia) and northern Ohio, west to extreme eastern Nebraska. In Indiana and Illinois it is known from near the northern border (type locality Cleveland in Henry county, Ill.) to south of a median line across these states.

The fact that *volantum*, like its southeastern relative *bradleyi* Rehn and Hebard, lives only on plants which grow out of the water, is an important reason why the limits of distribution are still poorly understood. It is usually possible to secure specimens only from a boat or by wading in waist-deep water.

Cedar Lake: Aug. 11, 1887, 1♀, Hart and Garman. **Cary:** Aug. 7, 1905, 2♀, Gerhard. **Peoria:** 1♀, HC.

Conocephalus Thunberg

KEY TO SPECIES

1. Caudal tibiae armed at distal extremity with three pairs of spurs.....2
Caudal tibiae armed at distal extremity with one pair of spurs. Prosternum unarmed. Male cerci very slender, with an elongate median tooth. Green or brown. Normally brachypterous, occasionally macropterous. Ovipositor distinctly shorter to distinctly longer than caudal femur....**saltans**, p. 218
2. Male cerci armed with a heavy mesal tooth, fig. 131.....3
Male cerci armed with a more delicate tooth, fig. 135, mesal portion of surface swollen and elongate ovate. Brachypterous, rarely macropterous.....6
3. Male cerci with distal portion depressed and with apex broad and rounded, fig. 131. Ovipositor nearly straight and of medium length for genus. General coloration green.....4

CONOCEPHALUS—KEY TO SPECIES—CONT'D

- Male cerci with distal portion not at all depressed and with apex acuminate, fig. 136. Normally brachypterous, very rarely macropterous.....5
4. Male cerci with distal portion weakly depressed, the depression general and not more decided on the inner side, fig. 132. Ovipositor averaging slightly narrower (in vertical sense) and shorter. Always macropterous but degree highly variable.....**fasciatus fasciatus**, p. 216
- Male cerci with distal portion more decidedly produced and very decidedly depressed, particularly on the inner side, fig. 131. Ovipositor averaging heavier and longer. Normally brachypterous, rarely macropterous..
.....**brevipennis**, p. 216
5. Male cerci with distal portion short, bluntly conical, fig. 136. Ovipositor much shorter than caudal femur. Vertex broad, very weakly ascending. General coloration brown, rarely greenish on sides. Sylvan, terrestrial.....
.....**nemoralis**, p. 216
- Male cerci with distal portion very elongate, with apex strongly acuminate, fig. 139. Ovipositor very much longer than caudal femur. Vertex very broad, not ascending. General coloration green, sometimes pale brown. Prefers grasses growing on poorer soil.....**strictus**, p. 217
6. Coloration solid, distinctive and vivid; abdomen wholly or in large part black, tegmina and caudal legs rich green. Male cerci shorter. Form slightly more robust. Ovipositor much shorter, considerably longer than to shorter than caudal femur.....**nigropleurum**, p. 217
- Brown or brownish buff, head and pronotum trifasciate. Male cerci longer. Form slightly more slender. Ovipositor exceedingly elongate, very much longer than caudal femur. Inhabits marsh vegetation. Exceedingly rapid in movements.....**attenuatus**, p. 217

C. fasciatus fasciatus (DeGeer).—A series of 205 specimens of this common species is before us from all parts of Illinois. Some of these show extreme macropterism.

C. brevipennis (Scudder).—Scudder's *ensifer*, described from Lawn Ridge, Ill. in 1862, was placed as a synonym by Rehn and Hebard in 1915.

The present material is variable in size but averages small, two males from Chicago being the smallest we have seen.

Though occurring over the entire state, this species is never as generally distributed as the preceding. It appears to be most abundant in the northern portion of Illinois.

Thirty-seven males and 55 females, of which a single female from Dubois is macropterous, taken July 25 to September 27, are from Zion, Beach, Waukegan, Winnetka, Kenilworth, Chicago, Bowmanville, Antioch, Channel Lake, Lake Villa, Sun Lake, Long Lake, Wauconda, Algonquin, Port Byron, Bloomington, Havana, Urbana, Champaign, Dubois, Shawneetown, Jonesboro, Karnak, Olive Branch.

C. nemoralis (Scudder).—This insect inhabits the undergrowth on the borders of and in openings in the woods, or open woodlands.

It occurs over all of Illinois, material from Lone Rock in southern Wisconsin indicating a known limit of distribution northward.

Twenty-eight males and 31 females, taken August 17 to October 15, are from Willow Springs, Starved Rock, Rock Island, Muncie, Urbana, Monticello, Charleston, Farina, Hillsboro, Hardin, Grafton, Lawrenceville, Clay City, Dubois, Carbondale, Herod, Golconda, Karnak, Olive Branch, Cache. A single female is macropterous, this being a rare condition in *nemoralis*.

At Hardin a female was found ovipositing in an apple.

C. strictus (Scudder).—This species prefers grasses growing on poor soil. Material from as far north as Lone Rock in southern Wisconsin is before us, indicating that *strictus* is present throughout Illinois.

Seventy-six males, 89 females, of which a pair is macropterous and 1♀ nearly macropterous, taken August 5 to October 13, and 11 immature individuals, are from Chicago, Antioch, Lake Villa, Deep Lake,

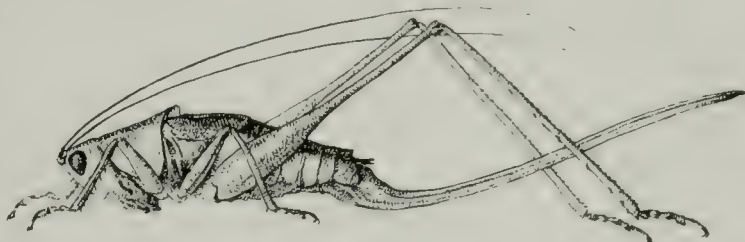


Fig. 159.—An adult female of the meadow katydid *Conocephalus strictus* (Scudder). $\times 2$.

Long Lake, Algonquin, Amboy, Riverside, Downers Grove, Milan, Moline, Rock Island, St. Anne, Forest City, Devil's Hole, Quiver Lake, Muncie, Urbana, Champaign, Monticello, Borton, Charleston, Hillsboro, Alton, Clay City, Norris City, Shawneetown, Marion, Herod, Elizabethtown, Ullin.

C. nigropleurum (Bruner).—Rehn and Hebard (1915b) recorded this handsome hygrophilous species from Watertown, Ill. It is certainly much more abundant in the northern portions of Illinois and Indiana than to the south. Southern known limits are Urbana, White Heath and Alton, but as it is known in southeastern Indiana from Gibson county, it will probably be found in favorable situations throughout Illinois.

Twenty-one males, 18 females, taken August 1 to September 10, and 11 immature individuals are from Beach (in swamp), Winnetka, Kenilworth, Bowmanville, Antioch (in tamarack bog), Cedar Lake (in tamarack swamp), Deep Lake, Lake Villa (in swamp), Wauconda, Algonquin, Argo, Havana, Urbana, White Heath (in woods), Alton.

C. attenuatus (Scudder).—This species was described from material from "Illinois," originally referred to *Xiphidion* in 1869. Rehn and Hebard (1915b) recorded it from Watertown, Ill.

Not only does brachypterism and macropterism give certain individuals a different general appearance, but in Illinois a color phase with legs rich green is frequently developed, very much in contrast

with normal individuals in which the legs, like the other portions of the insect, are various shades of brown.

The species probably does not occur in extreme southern Illinois, but though Putnam is at present a southern known limit point, *attenuatus* will probably be found further south than that, as it is known in Indiana south to Knox county. It is an inhabitant of swamp vegetation. Individuals are much more rapid in their movements and alert than are those of our more frequently encountered species of the genus.

Antioch: Aug. 27, 1932, 2♂, Ross and Mohr. **Lake Villa:** Aug. 9 and 10, 1906, 6♂, 6♀, 6 juv., swamp. **Grays Lake:** Aug. 27, 1932, 20♂, 18♀, Ross and Mohr. **Wauconda:** Aug. 23, 1932, 2♂, 1♀, all teneral, 1 juv.♀, Ross and Mohr. **Algonquin:** Aug. 10 to Sept. 5, 1905 and 1910, 6♂, 3♀, 2 juv. **Putnam:** Sept. 26, 1933, 7♂, 1♀, Ross and Mohr. A few of these specimens are macropterous, the others brachypterous.

C. saltans (Scudder).—The present series has the tegmina very decidedly reduced, except one male which is semimacropterous.

This insect, preferring grasses growing on dry poor soil, is found throughout Illinois. Northern limits from material before us are West Spring Green and Lone Rock in southern Wisconsin.

Zion: Aug. 25, 1932, 1♂, 3♀, Ross and Mohr. **Beach:** Aug. 21 to 26, 1906 and 1932, 25♂, 21♀, sand ridges and swamps. **Waukegan:** Aug. 18, 1906, 1♂, 1♀. **St. Anne:** Aug. 28, 1932, 1♂, 1♀, Ross and Mohr. **Devil's Hole:** Sept. 11, 1910, 1♂.

DECTICINAE

Atlanticus Scudder

KEY TO SPECIES

1. Male tegmina projecting caudad of pronotal disk a distance considerably exceeding half the length of pronotum. Pronotum of male proportionately large. Subgenital plate of female with lateral apices exceedingly broadly and evenly rounded. Prosternal spines very short. Male cerci relatively short, robust. Subgenital plate of male with distal emargination shallowly rounded, angulate.....**testaceus**, p. 219
- Male tegmina projecting caudad of pronotal disk much less than half the length of pronotum. Pronotum of male shorter and narrower. Subgenital plate of female with lateral apices much less broadly rounded and showing angulation. Subgenital plate of male with distal emargination normally decidedly angulate-emarginate.....2
2. Prosternal spines very short. Caudal femora less elongate. Pronotal disk averaging broader at the nearly or definitely truncate caudal margin. Ultimate tergite of male with projections on each side very weak, bluntly obtuse-angulate. Male cerci relatively short and robust. Smaller...**davisi**, p. 219
- Prosternal spines elongate. Caudal femora very elongate for genus. On the average the pronotal disk narrower at the very broadly convex caudal

ATLANTICUS—KEY TO SPECIES—CONT'D

margin. Ultimate tergite of male with projections on each side more decided with apices acute. Male cerci relatively elongate. Larger.....

.....**americanus hesperus**, p. 219

A. testaceus (Scudder).—This species, found throughout woodlands in Illinois, was generally recognized as *pachymerus* until 1916. It was recorded from Rock Island, Ill. as *Thyreonotus pachymerus* by McNeill in 1891 and from Moline and Peoria correctly by Rehn and Hebard in 1916.

We have studied 14♂, 20♀ and 1 juv.♀, taken June 10 to September 10, and 17 immature individuals, all from **Winnetka, Deep Lake, Savanna, Downers Grove, Willow Springs, Beverly Hills, Palos Park, Joliet, Putnam, Moline, Muncie, Homer, Grafton, Dubois, Prospect Hill, Parker.**

A. davisii Rehn and Hebard.—It is almost certain that this species will be found in southern Illinois, as it is known from southern Indiana and Keokuk in extreme southeastern Iowa.

A. americanus hesperus Hebard.—Described from "Tennessee," the type female of *americanus* (Saussure) in the Geneva Museum has been examined for us by Dr. Carl, whose sketch of the subgenital plate shows its median emargination to be very deep and decidedly narrow. Material from the Appalachian mountains in North Carolina, eastern Tennessee and Georgia represents the eastern race, whereas all material before us from points in Tennessee to the west represents the western race. We believe therefore that the type came from the Appalachians in extreme eastern Tennessee. Large series before us show that the species divides into an eastern and a western race and this feature is characteristic of the eastern race, of which *Decticus derogatus* Scudder is a synonym. The eastern race is found from New Hampshire (probably southern) and Dedham, Mass., south throughout the Appalachians, at lower elevations known as far south as Plummers Island, Md. (material in the author's collection) and Greensboro, N. C.

The western race (Hebard 1934) is found from the gulf coast north to southern Ohio, Indiana and Illinois and west to the Mississippi.

Alto Pass is a northwestern limit point for this race, previously not known from Illinois, where it is apparently limited to the southern portion of the state.

Alto Pass: Aug. 16, 1909, 1♀. **Thebes:** July 31, 1905, 1♂.

Length of body: ♂, 25 mm. (abdomen retracted); ♀, 27.5 mm. Length of pronotum: ♂, 10.7 mm.; ♀, 11.8 mm. Caudal width of pronotal disk: ♂, 7 mm.; ♀, 7 mm. Projection of male tegmina: 3.3 mm. Length of caudal femur: ♂, 27.7 mm.; ♀, 30.4 mm. Length of ovipositor: 26.3 mm.

GRYLLACRINAE

Camptonotus Uhler

C. carolinensis (Gerstaecker).—This species has received considerable attention because of its unique habit of rolling leaves into a nest, in which it hides.

Bluffs: Aug. 19, 1917, 1 juv.♀. **Carbondale:** Sept. 23 to 26, 1909, 2♂, 2♀, Gerhard, *FM*. **Boskydell:** Sept. 26, 1909, 2♂, Gerhard, *FM*. **Alto Pass:** Aug. 13, 1891, 1♀, Hart and Shiga. **Metropolis:** Sept. 23, 1924, 1♀, Frison.

RHAPHIDOPHORINAE⁹**Diestrammena** Brunner**D. apicalis** Brunner.

- 1888 *Diestrammena apicalis* Brunner, Abh. zool.-bot. Ges. Wien., vol. 38, pp. 298-299. ♀, Japan.
- 1904 *Diestrammena unicolor* Morse, Psyche, vol. 11, p. 80. Chicago, Ill., in greenhouse. (Not of Brunner 1888).
- 1907 *Diestrammena unicolor* Caudell, Can. Ent., vol. 39, p. 290. Citation of last.
- 1908 *Diestrammena apicalis* Matsumura & Shiraki, Journ. Coll. Agr. Sapporo, vol. 3, no. 1, p. 77. Japanese records, description and measurements.
- 1916 *Diestrammena apicalis* Chopard, Bull. Soc. Ent. France, 1916, p. 156. Characterization in key, partly erroneous.
- 1920 *Diestrammena unicolor* Blatchley, Orth. Northeast. Am., p. 612. Citation of Morse's 1904 record.
- 1921 *Diestrammena apicalis* Chopard, Bull. Soc. Ent. France, 1921, p. 210. *Unicolor* and *apicalis* differentiated as result of type examination.
- 1925 *Tachycines asynamorus* Hebard, Proc. Acad. Nat. Sci. Phil., vol. 77, p. 146. In part, Morse's 1904 record erroneously assigned to this species, following suggestion made by Chopard in 1914.
- 1928 *Diestrammena apicalis* Karny, Stett. Ent. Zeit., vol. 89, p. 307. Hiogo, Japan. Notes on leg armature and proportions.
- 1930 *Diestrammena apicalis* Karny, Ann. Naturh. Mus. Wien., vol. 44, p. 173. Notes on ♀ holotype in Vienna Museum and on coloration.

The various records of *Diestrammena unicolor* Brunner from European greenhouses by Wünn, Chopard and others have been demonstrated to have been based upon *Tachycines asynamorus* Adelung, and it has been assumed in recent years that the specimen from Chicago recorded as *unicolor* in 1904 by Morse was also that species. Inveighing against the failure of American students to acquaint themselves with the literature in which the identity of the insect had been pointed out, Karny in 1930, pp. 173-174, makes the statement that members of the genus *Diestrammena* are so far as known confined to the eastern Asiatic region, and that it is highly unlikely that any species

⁹A comprehensive treatment of the North American species has been recently completed by T. H. Hubbell, and is expected to appear at an early date.

of that genus should occur in America; he refers all North American records of *D. "marmorata"* and *D. unicolor* without exception to *Tachycines asynamorus*. It was surprising therefore to find in the collections submitted for study by the ILLINOIS STATE NATURAL HISTORY SURVEY specimens from Chicago greenhouses which show that *apicalis* was established there for a period of not less than four years. Morse's identification of the species proves to have been as accurate as the state of the literature in 1904 would permit.

Diestrammena apicalis differs from *D. unicolor* and from all of the other species of the genus, except *D. minuta* Chopard of Tonkin, in the character of the distal armature of the cephalic tibiae. In *apicalis* and *minuta* the apex of the tibia is unarmed dorsad (except for a single small distodorsal spine sometimes present in *minuta*), and there is no median spinule between the paired distoventral spurs. This feature distinguishes these two species at once, not only from all of the remaining species of *Diestrammena*, but also from *Tachycines asynamorus*, the only other member of this old world tribe known to be adventive to North America; in all of these a small median spine or spinule is present between the two larger distoventral spurs, and a distodorsal spine is present on one or both sides. From *Diestrammena minuta* the present species is distinguished by its greater size, and in the female by the form of the subgenital plate—in *apicalis* this is triangular and straight sided while in *minuta* it is more broadly triangular, with convex sides and acute apex. The relatively uniform coloration of *Diestrammena apicalis*, together with the differences in the armature of the cephalic tibiae, serves to differentiate all instars of this species from those of the strikingly maculate *Tachycines asynamorus*.

The following specimens in the collection of the ILLINOIS STATE NATURAL HISTORY SURVEY, and the original material recorded by Morse, are believed to constitute the only records of the occurrence of the species outside of Japan.

Chicago: Apr. 24, 1906, 2 ♂, 1 ♀, 2 juv. ♂, 4 juv. ♀ (the immature individuals all more than half grown); taken with *Tachycines asynamorus* which was apparently the more abundant; Dec. 28, 1907, 3 small juv. ♂ taken with adults and immature specimens of *Tachycines asynamorus* in Lincoln Park greenhouse, Zetek.

Tachycines Adelung

T. asynamorus Adelung.

- 1902 *Tachycines asynamorus* Adelung, Ann. Mus. Zool. Petersbourg, vol. 7, pp. 59-62, text figs. a, b, c. ♂, ♀, St. Petersburg, Russia, in palm house, introduced on plants.
- 1920 *Diestrammena japonica* Blatchley, Orth. Northeast. Am., p. 611, fig. 205.

- 1925 *Tachycines asynamorus* Hebard, Proc. Acad. Nat. Sci. Phil., vol. 77, p. 146. Synonymy, distribution in North America.
- 1930 *Tachycines asynamorus* Karny, Ann. Naturh. Mus. Wien., vol. 44, pp. 174-176. Full discussion of synonymy, specific characters, distribution.

This widely distributed and aggressive adventive species, apparently of Chinese and Manchurian origin, has been recorded from greenhouses in a large number of European and North American localities. In addition to its many other distinctive characters, the presence of a third smaller spine midway between the two distoventral spurs of the cephalic tibiae is a feature which does not occur in any other native or adventive North American raphidophorid. Long referred to as *Diestrammena marmorata* by authors (not *Locusta marmorata* DeHaan 1843), and often recorded in Europe as *D. unicolor* (not of Brunner 1888), its true identity has only gradually become recognized in this country. The name *japanica*, proposed by Blatchley in 1920 to replace DeHaan's preoccupied *marmorata*, does not apply to the insect for which Blatchley used it but to the true *marmorata* DeHaan, which is a Japanese species not known to be adventive.

Chicago: Apr. 24, 1906, 4♂, 18♀, 11 juv.♂, 7 juv.♀; Oct. 4, 1911, 1♂, 2♀, NM; Dec. 28, 1907, 1♂, 4♀, 1 juv.♀, in Lincoln Park greenhouse, Zetek. **Urbana:** summer of 1906, 1♂ in greenhouse; Oct. 20, 1904, 1♂, 1♀, in university greenhouse; June 17, 1933, 2♂, Chouinard, in basement. **Decatur:** Oct. 1932, 1♀ in basement.

Hadenoecus Scudder

H. puteanus Scudder.—There is a slight possibility that this species may reach southern Illinois, as it has been found to have a wide geographic range and to occur in a variety of environmental conditions. Its known limits extend from the Okefenokee swamp in southeastern Georgia north to central Pennsylvania and west to central Kentucky, Monticello in south-central Mississippi and the Cumberland plateau in Tennessee. Unrecorded series are in the collection of the Museum of Zoology of the University of Michigan from Allardt in Fentress county, Grassy Cove in Cumberland county, and Middle creek on the south slopes of Signal Mountain in Hamilton county, Tenn. Chopard (1931) has recently presented evidence to show that the genus *Hadenoecus* Scudder should be referred to the tribe Dolichopodini rather than to the Ceuthophilini.

Ceuthophilus Scudder

Excellent taxonomic characters present in the male genitalia in this genus render identification of specimens of this sex relatively easy and certain; females possess no such distinctive characters and are often difficult to determine. Many of the species exhibit striking peculiarities of

form and coloration which are diagnostic, but others are so variable in these respects or so similar to one another that size, form and pattern are unreliable criteria. It is a matter of some difficulty to construct a brief key which will invariably distinguish even the species of a restricted area, and that which follows is intended for use only with Illinois material—additional species present in adjacent regions are not included.

The most important taxonomic characters of the male are found in the terminal abdominal tergites, the subgenital plate, the supra-anal plate (composed of a basal portion, the epiproct, and a smaller deflexed distal portion, the suranale), and particularly in the pseudosternite. The last is a sclerotized arch lying below the anus and paraprocts, and concealed by the upper margin of the subgenital plate. The inner rim of this arch, particularly its dorsal edge, is variously modified to form flanges, paired lobes or median processes, which are highly diagnostic of the species and often unique in form. The apex of the arch is a submembranous flap deflexed cephalad of the specializations of the dorsal rim; this portion is the cephalic lobe, usually simple but often characteristically modified. To observe the pseudosternite the subgenital plate must usually be pulled out far enough to expose the interior of the genital cavity; this should always be done in mounting fresh specimens, and in dried material can be accomplished by softening the tip of the abdomen with warm water or a drop of household ammonia, or by relaxing the entire specimen in the usual manner.

KEY TO SPECIES

1. Ventral keel of caudal metatarsus with a row of short stout setae extending at least halfway to apex. *Male*—dorsum of pseudosternite with a median, vertically compressed, caudally directed process; sides of subgenital plate convergent to narrowly rounded, briefly notched apex. *Female*—ovipositor not more than 5 mm. long; teeth and apices of dorsal valves elongate, aciculate. **elegans**, new species, p. 237
Ventral keel of caudal metatarsus not setose. Remaining features not as in alternative; ovipositor more than 5.5 mm. long except in *divergens*. 2
2. Caudal margin of ninth abdominal tergite of male strikingly upturned, recurvate. Dorsum of pseudosternite an erect, acute spinose process. Female subgenital plate tridentate at apex, the points acute. **seclusus**, p. 227
Caudal margin of ninth abdominal tergite of male not strikingly upturned. Pseudosternite either without median process or such process not spinose. Female subgenital plate with entire margin. 3
3. Males (abdomen without apical ovipositor). 4
Females (abdomen with apical ovipositor, fig. 160). 11
4. Dorsum of pseudosternite forming an erect median process with spatulate, subtruncate apex. Caudal margin of ninth abdominal tergite broadly angulate-emarginate. Caudal tibia usually distinctly sinuate proximad. **maculatus**, p. 226
Inner rim of pseudosternite arch thickened, flanged or biauriculate; dorsum not forming a median process. Caudal margin of ninth abdominal tergite

CEUTHOPHILUS—KEY TO SPECIES—CONT'D

- not broadly emarginate except sometimes in *latens*. Caudal tibiae rarely distinctly sinuate proximad.....5
5. Cephalic lobe of pseudosternite bilobed. Inner rim of arch continuously laminate-flanged, or with paired auriculae bearing spinose, caudally directed processes.....6
- Cephalic lobe of pseudosternite with entire margin. Inner rim of arch thickened or auriculate, the auriculae if present not spinose.....8
6. Caudal tibial spurs conspicuously blackened at base. Pseudosternite with a pair of small dorsolateral auriculae giving rise to caudally directed spinose processes.....*latens*, p. 228
- Caudal tibial spurs not blackened at base, at most slightly infumate. Inner rim of pseudosternite continuously flanged with a thin recurvate lamina..7
7. Dorsal margin of pseudosternite flange evenly convex. Cephalic femur/pronotum ratio 1.5-2.1, average in this region 1.75. Coloration normally transversely banded.....*gracilipes*, p. 229
- Dorsal margin of pseudosternite flange roundly angulate mesad, deflexed at this point. Cephalic femur/pronotum ratio 1.2-1.6, average 1.4. Dorsum with a broad orange mediolongitudinal stripe.....*meridionalis*, p. 228
8. Ventrocephalic carina of caudal femur with 18-40, commonly 20-25 small subequal denticulations. Pseudosternite with conspicuous auriculae. Ventral margin of lateral lobe of pronotum brown bordered, this sometimes dilute.....9
- Ventrocephalic carina of caudal femur with two to 15, commonly eight to 10 denticulations and spines; those in middle of series the largest, length often equaling depth of caudal tibia. Inner rim of pseudosternite thickened or weakly auriculate. Ventral portion of lateral lobe of pronotum pale..10
9. Auriculae of pseudosternite laminate, curved, separated by a space as broad as one of them. Lobes of subgenital plate distinctly digitate at apex. Caudal tibia darkened above and on sides between spur bases; areas at base of spurs pale, concolorous with spurs.....*brevipes*, p. 229
- Auriculae of pseudosternite thickened, triquetrous with impressed dorsal surface, separated by a space not more than half as broad as one of them. Lobes of subgenital plate bluntly conical on either side of median sulcus. Caudal tibia uniform pale brownish.....*williamsoni*, new species, p. 230
10. Dorsal surface dull. Yellow- or red-brown, indistinctly maculate with darker brown, without median pale stripe. Caudal femur in this region 12-16 mm. long. Caudal tibia normally with two subdistal ventral spurs.....*uhleri*, p. 236
- Dorsal surface polished, at least on thorax. Reddish brown, more or less darkened on either side of narrow pale median stripe. Caudal femur in this region 8-12 mm. long. Caudal tibia commonly with a single subdistal ventral spur.....*divergens*, p. 237
11. Ventrocephalic carina of caudal femur with 18-40, commonly 20-25 denticulations. Ventrolateral margins of pronotum broadly bordered with brownish, this sometimes dilute but continuous across ventrocephalic angle.....12
- Ventrocephalic carina of caudal femur with none to 15, commonly less than 12 denticulations. Ventral portions of lateral lobes of pronotum pale, or if a dark marginal band is present it is interrupted by the distinctly pale ventrocephalic angle.....13

CEUTHOPHILUS—KEY TO SPECIES—CONCL'D

12. Dorsal surface distinctly polished. Coloration dark. Ovipositor in this region 6.6-7.5 mm. long. Caudal tibia darkened between spur bases.....
.....**brevipes**, p. 229
- Dorsal surface weakly polished. Coloration largely pale, distinctly transversely banded. Ovipositor 8.2-11.4 mm. long. Caudal tibia nearly uniform pale brown.....**williamsoni**, new species, p. 230
13. Caudal femur less than 12 mm. and ovipositor less than 6 mm. long. Ovipositor/pronotum ratio .8-1.4, average 1.2. Dorsocephalic angle of middle coxa acutely produced. Dorsum of thorax polished and with narrow pale median stripe. Caudal tibial spurs dorsally bicarinate, external face multisetose.....**divergens**, p. 237
- Caudal femur at least 12 mm. and ovipositor at least 6 mm. long. Ovipositor/pronotum ratio 1.5-2.3. Dorsocephalic angle of middle coxa obtuse to slightly acute, scarcely produced. With or without pale median stripe. Caudal tibial spurs commonly unicarinate dorsad and/or external face sparsely setose; if bicarinate and multisetose dorsal surface of body dull. 14
14. Thorax and base of abdomen with a broad reddish to orange-yellow median stripe, continuous and with well defined margins, contrastingly bordered by deeply infuscated dorsolateral areas. Caudal femur suffused with brownish distad, with numerous indistinct pale rounded maculae in this portion.....15
- Dorsum without such a stripe, or if indicated it is a mere hairline or more or less interrupted and the dorsolateral dark areas but little contrasted and much broken by paler markings. Caudal femur with prominent scalari-form pattern; if distally suffused, without numerous rounded pale maculae.....16
15. Caudal tibial spurs distinctly blackened at base. Infuscated portions of dorsum intensely black, nearly solid. Ovipositor teeth appearing crowded toward apex, proximal interval not wider than rest.....**latens**, p. 228
- Caudal tibial spurs pale, or at most slightly infumate at base. Infuscated portions of dorsum brownish black, in places dilute, and enclosing numbers of small pale rounded maculae. Ovipositor teeth not appearing crowded, proximal interval almost always distinctly wider than rest.....
.....**meridionalis**, p. 228
16. Dorsal surface dull to very weakly polished. Red- or yellowish brown indistinctly mottled with darker brown. Caudal tibial spurs dorsally bicarinate. Pronotum in lateral aspect strongly narrowed ventrad....**uhleri**, p. 236
- Dorsal surface polished, with contrasted pattern, distinctly banded or maculate or both. Caudal tibial spurs normally unicarinate, but outer carina sometimes weakly indicated. Pronotum in lateral aspect subquadrate, weakly narrowed ventrad.....17
17. Caudal femur 12-15 mm. and ovipositor 6.8-9.5 mm. long. Cephalic femur, pronotum ratio 1.1-1.4, average in this region 1.2. Caudal tibia normally with a single subdistal ventral spur. Dorsum much maculate, often with interrupted pale median stripe or row of large maculae...**maculatus**, p. 226
- Caudal femur 17-23 mm. and ovipositor 11-15 mm. long. Cephalic femur/pronotum ratio 1.4-1.9, average in this region 1.6. Caudal tibia normally with two subdistal ventral spurs. Dorsum transversely banded, more or less maculate; pale median stripe seldom indicated in this region.....**gracilipes**, p. 229

C. maculatus (Harris).

- 1841 *Rhaphidorphora maculata* Harris, Rept. Insects Mass., p. 126. Massachusetts.
- 1920 *Ceuthophilus maculatus* Blatchley, Orth. Northeast. Am., pp. 622-624, fig. 207; pl. VI, fig. b; pl. VII, figs. d, j. Statement of range in part incorrect; *latebricola* Scudder correctly and *bicolor* Scudder incorrectly synonymized.
- 1920 *Ceuthophilus maculatus* Morse, Orth. New Eng., pp. 379-380, fig. 60; pl. 14, figs. 24, 25.
- 1922 *Ceuthophilus maculatus* E. M. Walker, Ann. Ent. Soc. Am., vol. 15, p. 26; pl. III, fig. 27. ♂ genitalia described and figured.
- 1925 *Ceuthophilus maculatus* Hebard, Proc. Acad. Nat. Sci. Phil., vol. 77, pp. 140-141. Range correctly stated, except Kentucky, Missouri and Kansas (based on doubtful or erroneous records in literature); *seclusus* Scudder incorrectly synonymized.

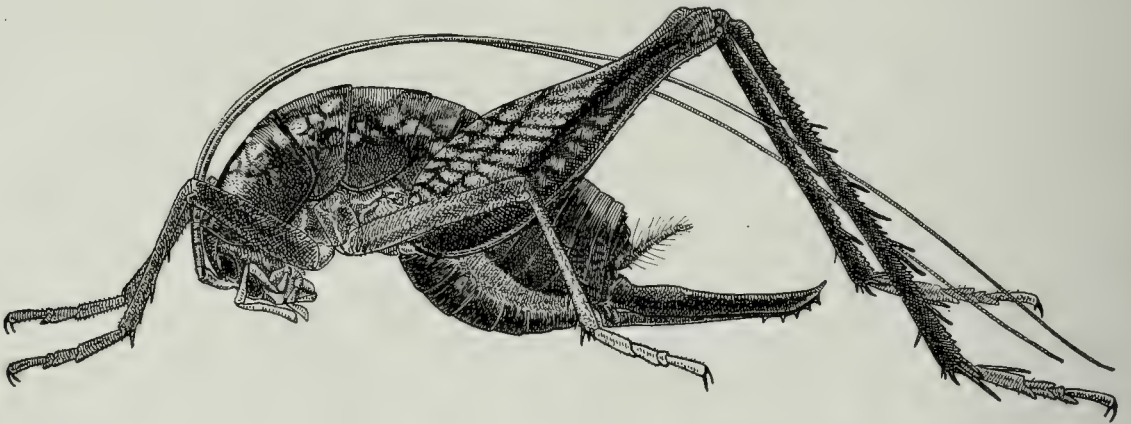


Fig. 160.—Adult female of the camel cricket *Ceuthophilus maculatus* (Harris). $\times 2$.

The range of this species is extensive, with limits which may be given as follows: Nova Scotia and New Brunswick westward north of Lake Superior to Lake Winnipeg, Man., thence south through Devil's Lake, N. D., Springfield, S. D. and West Point, Neb.; the species is not known from Kansas nor certainly from Missouri, but extends south along the Mississippi to West Helena, Ark.; east of the Mississippi its southern limits are reached in southern Illinois, Indiana and central Ohio, while farther east it is apparently common throughout New England and New York, but is represented in the collections examined from only four localities south of Long Island—Rockville and Chestnut Hill, Pa., "Maryland" and the District of Columbia. These records are based partly upon a specimen from the Kabina-Kagami river, Algoma District, Ont., in the Canadian National Collection; unrecorded series from Arkansas in the Museum of Zoology, University of Michigan; a female labeled "Maryland," collected by Uhler, one of the paratypes of *C. terrestris* Scudder in the Museum of Comparative Zoology; and three specimens from Washington, D. C., part of the type series of *C. latebricola* Scudder in the Museum of Comparative Zoology and the Hebard collection. The Pennsylvania records are based on a single female of doubtful identity from each locality, in the Hebard collection.

As an illustration of the extent of the confusion existing in the literature of the genus *Ceuthophilus*, and the consequent uncertainty attendant upon the use of published locality records, it may be noted that examination of the original material (or in a few cases, strong circumstantial evidence) shows that *Ceuthophilus maculatus* has at various times been recorded under the names *maculatus* and the synonymous *latebricola*, and as *blatchleyi*, *gracilipes*, *brevipes*, *lapidicola*, *seclusus*, *tenebrarum* and *terrestris*. *Machamala armata* Walker is probably a synonym, and *Ceuthophilus scriptus* Walker, described from an unknown locality, is possibly another. On the other hand, among the specimens which had been recorded as *C. maculatus* or *C. latebricola* were found the following species: *brevipes*, *tenebrarum*, *pallidipes*, *lapidicola*, *divergens*, *nigricans* and *nodulosus*, while the Colorado records of the species were probably based upon *uniformis*.

Ceuthophilus maculatus was correctly recorded from Moline by McNeill in 1891 and Scudder in 1894. Illinois records of *C. tenebrarum* (Scudder 1894), (Kirby 1906) and (Blatchley 1920), are based on a paratypic immature male from southern Illinois and on a paratypic male and female, both immature, the latter selected as allotype by Blatchley (1920) from Port Byron, Ill. Examination of these specimens, now in the Museum of Comparative Zoology and the Hebard collection, shows that they are referable either to *maculatus* or to the very closely allied *tenebrarum*; since *maculatus* is common over the whole of Illinois while *tenebrarum* appears to be restricted to a small area in southern Ohio and adjacent north-central Kentucky, it appears best to assign these specimens to the present species. According to notes received from Caudell the Port Byron specimens are a part of the series recorded by McNeill in 1891 as *Ceuthophilus latens*.

Chicago: 3♂, 1♀, Brues, *BC*; 4♂, 3♀, *MCZ*. **Glenview:** Sept. 22, 1918, 1♀, Liljeblad, *MMZ*. **Fox Lake:** Aug. 2, 1922, 1♂, 1♀, Frison. **Algonquin:** Sept. 15, 1905, 1♂, 1♀, Nason. **Sycamore:** Aug. 14, 1♂, Dawson, *OSU*. **Summit:** 1♂, Zetek. **Moline:** June 6, 1♂, McNeill, *MCZ*. **Newman:** May 30, 1921, 2♀, Vinkler. **Mascoutah:** July 17, 1906, 2♂, 2♀. **Dubois:** June 21, 1905, 1♂, 4♀; July 2, 1909, 1♀; Aug. 9, 1929, 6♂, 11♀, Hubbell, *MMZ*.

C. seclusus Scudder.

- 1894 *Ceuthophilus seclusus* Scudder, Proc. Am. Acad. Arts and Sci., vol. 30, p. 45. ♂, ♀, Dallas and Crawford counties, Iowa; West Point, Neb., in error.
- 1920 *Ceuthophilus seclusus* Blatchley, Orth. Northeast. Am., p. 629, pl. VI, figs. m, o; pl. VII, figs. g, p.
- 1931 *Ceuthophilus seclusus* Hubbell in Hebard, Proc. Acad. Nat. Sci. Phil., vol. 83, p. 205. Synonymy, characters of ♀, statement of range.

This species undoubtedly occurs in Illinois, though it has not yet been taken in the state. It is one of the most abundant species of the

Ozark plateaus and is widely distributed in the prairie regions, where it occurs in open woodland and in stream-margin forests. Vigo county, Ind. is the easternmost record.

C. latens Scudder.

1862 *Ceuthophilus latens* Scudder, Bost. Journ. Nat. Hist., vol. 7, p. 437. ♀, Illinois.

1920 *Ceuthophilus latens* Blatchley, Orth. Northeast. Am., p. 630, pl. VI, figs. g, l; pl. VII, figs. f, q. In part, records from Texas and eastern Nebraska probably, and that from Cheboygan county, Mich. certainly, erroneous.

This well known and easily recognizable species ranges from southern New England south on the coastal plain and piedmont to Maryland and Virginia; westward its northern limits are found in central New York, extreme southern Ontario, southern Michigan and southeastern Minnesota; this last is based on two males from Hennepin county, Minn., July 17, 1927, in the Hebard collection and that of the University of Minnesota. Limital records on the west are Cedar Rapids and Iowa City in Iowa, excluding Bruner's questionable record from eastern Nebraska, cited by Blatchley (1920). The species occurs throughout Illinois, Indiana and Ohio, and probably most of Pennsylvania and Kentucky; it reaches its known southern limits at Clarksville and on the Cumberland plateau in northern Tennessee, these last records being based on unrecorded series in the University of Michigan Museum of Zoology.

Ceuthophilus latens was described from Illinois by Scudder in 1862, and it has since been recorded from the state by McNeill (1891), Scudder (1894) and Blatchley (1920).

Chicago: Aug., 2 ♂, MMZ. **Savanna:** July 21 to Aug. 1, 1892, 1 ♂, 1 ♀. **Willow Springs:** July 14 to Aug. 24, 1910 to 1914, 3 ♂, 3 ♀, FM. **Palos Park:** July 24, 1904, 1 ♂, Wolcott; Sept. 3 to 11, 1910 and 1911, 2 ♂, 2 ♀, FM. **Danville:** July 7, 1906, 3 ♂, 1 ♀. **Muncie:** June 13, 1905, 1 ♂. **Urbana:** June 10, 1891, 1 juv. ♂, 2 juv. ♀, Martin; July 6, 1901, 1 ♀, NM; July 22, 1926, 2 ♂, 6 ♀, Frison; Sept. 18, 1933, 1 ♂, Ross. **Mahomet:** Aug. 26, 1898, 1 ♂, Woodworth. **White Heath:** May 14, 1909, 1 juv. ♂. **Martinsville:** Aug. 8, 1929, 4 ♀, Hubbell, MMZ. **Parker:** June 12, 1907, 1 ♀.

C. meridionalis Scudder.

1894 *Ceuthophilus meridionalis* Scudder, Proc. Am. Acad. Arts and Sci., vol. 30, p. 66. ♂, "Chihuahua, Mexico," in error.

This species is the northern representative of *Ceuthophilus gracilipes* (Haldeman), from which it differs in its lesser size, greater robustness, characteristic armature of the caudal femora (fewer, heavier and less regular spines than in *gracilipes*), shorter and stouter legs, and in details of the concealed male genitalia. In coloration the two show average differences of considerable amount, *meridionalis* having typically a broad, plainly contrasted mediolongitudinal stripe of orange-yellow, and being otherwise much more intensively pigmented than typical

gracilipes. Locally *gracilipes* may approach *meridionalis* rather closely in coloration, but not, so far as observed, in the regions where the two might occur together.

Ceuthophilus meridionalis is a common species in the southern peninsula of Michigan, in southern Ontario and in northern and central Ohio and Indiana, replacing *gracilipes* in those regions. It should occur in northeastern Illinois, and probably does so. The statements about the habitat of *Ceuthophilus* species on page 236 of Shelford (1913) and the photograph (fig. 216) almost certainly apply to this species.

C. gracilipes (Haldeman).

- 1850 *Phalangopsis gracilipes* Haldeman, Proc. Am. Ass. Adv. Sci., vol. 2, p. 346. ♂, central Pennsylvania.
- 1920 *Ceuthophilus gracilipes* Blatchley, Orth. Northeast. Am., p. 630, fig. 209; pl. VI, fig. f; pl. VII, figs. a, b, r. In part, records from Michigan, central Ontario, Manitoba, Minnesota, Colorado and Chihuahua, Mex. erroneous, partly based on *meridionalis*.

This is the largest species of the genus, except *C. stygius* (Scudder). Its range, as determined by studies in progress, extends from Massachusetts and central New York, central Ohio and Indiana and southern Illinois, south to Liberty and Jackson counties in Florida, central Alabama and Vicksburg, Miss. It probably occurs throughout the piedmont, but only reaches the coastal plain from Virginia north to Long Island, and in the gulf states. The western limits are still in doubt; it occurs at West Helena, Ark., and immature specimens from Cliff Dweller's cave near Noel, Mo. are doubtfully referred to *gracilipes* by Hebard; a female in the Hebard collection is labeled Fairbury, Neb., but this record requires verification. Unrecorded series from Florida, Alabama and Arkansas are in the Museum of Zoology, University of Michigan.

Ceuthophilus gracilipes probably occurs only in the southernmost part of Illinois. It has been recorded from "Illinois" or from "southern Illinois" by Scudder (1862), Brunner (1888), McNeill (1891) and Scudder (1894); in the last "northern Illinois" is also given, doubtless in error.

Illinois: 1♀, Webster, HC. **Southern Illinois:** 1♂, Uhler, MCZ. **Herod:** Oct. 12, 1933, 2 juv. ♂, 1 juv. ♀, Frison and Ross. **Cypress Creek:** July 19, 1877, 1♂.

C. brevipes Scudder.

- 1862 *Ceuthophilus brevipes* Scudder, Bost. Journ. Nat. Hist., vol. 7, p. 434. ♂, ♀ (juv.), Grand Manan Island, N. B.
- 1894 *Ceuthophilus terrestris* Scudder, Proc. Am. Acad. Arts and Sci., vol. 30, pp. 46-47. In part, Moosehead Lake, Norway, Bethel and Gorham, Me.; Anticosti Island; Cambridge, Lowell and Nahant, Mass.

- 1905 *Ceuthophilus terrestris* Walker, Can. Ent., vol. 37, pp. 113-119, pl. V, fig. 4. Synonymy and comparison with other species.
- 1918 *Ceuthophilus terrestris* Piers, Trans. Nova Scotia Inst. Sci., vol. 14, pp. 327-328, pl. IV, fig. 25.
- 1920 *Ceuthophilus terrestris* Blatchley, Orth. Northeast. Am., p. 636, pl. VI, fig. h. In part, Newfoundland, Nova Scotia, New England, Michigan, Catskill mountains and Ithaca, N. Y.
- 1920 *Ceuthophilus terrestris* Morse, Orth. New Eng., pp. 375, 380, pl. 14, figs. 26, 27.
- 1929 *Ceuthophilus brevipes* Hubbell, Fla. Ent., vol. 13, p. 20. Types immature; *terrestris* Scudder (1894) a synonym. Male selected as single type by Rehn and Hebard in 1912, not found in Museum of Comparative Zoology in 1928.

Although no Illinois specimens of this easily recognizable species have been seen, it undoubtedly occurs at least in the northeastern parts of the state, as it is found throughout eastern Wisconsin and is known from numerous localities in Indiana. Unrecorded material from Dane and Oneida counties, Wis. is in the collections of W. S. Marshall, Morgan Hebard and the Field Museum of Natural History, and unrecorded series from various localities in Indiana are in the University of Michigan Museum of Zoology, the southernmost locality being Clifty state park on the Ohio river. The southernmost record in this part of the range is Horse cave, Ky. Shelford's (1913) record of *Ceuthophilus* species from the margin of tamarack forest in the Chicago region is very likely referable to *C. brevipes*, as that is one of the most characteristic habitats of the species in southern Michigan.

C. williamsoni Hubbell. NEW SPECIES.¹⁰—This species is closely allied to *C. brevipes* Scudder, from which it has probably been derived. It differs from that species in its larger average size, less polished surface, paler and more conspicuously banded coloration, and particularly in proportions and in details of the male genitalia. The legs average more slender and elongate than in *brevipes* from Michigan, Ohio and Indiana, in this respect resembling more closely the proportions of the Maryland and Virginia phase of that species. The most marked differences between the two are found in the pseudosternite of the male, that of *williamsoni* being uniquely specialized and sufficing in itself for recognition of the species. The female of *williamsoni* is less easily distinguished from that of *brevipes*, but the principal difference is a longer, more slender ovipositor.

In the following descriptions the figures in parentheses show range of variation as observed in the paratype series; spur and spine counts for holotype and allotype give the number for the right leg first. Color names refer to Ridgway (1912).

¹⁰ Named in remembrance of Edward Bruce Williamson, in admiration of his attainments as a naturalist and in sorrow for his loss.

HOLOTYPE—MALE

GENERAL.—Onondaga cave, Crawford county, Mo.: Sept. 15, 1930, Hubbell, *MMZ*. Length of body 16 mm. Dorsum weakly polished, with satiny sheen, minutely and sparsely setose, especially on abdomen.

HEAD.—Fastigium a low rounded eminence with bluntly conical apex, in lateral aspect less prominent than expanded mesal margins of antennal fossae. Length of eye 1.2 mm., ratio length/breadth 1.3 (to 1.5). Interocular space 1.4 (to 1.2) times as long as eye. Antenna 4.1 (to 4.9) times as long as caudal femur. Distal segment of maxillary palpus 1.9 (1.8-2.1) times as long as interocular space.

THORAX.—Surface smooth, foveolae shallowly impressed. Pronotum broad, in lateral aspect subquadrate, longer than apparent height; sides weakly convergent ventrad, ventrocephalic angle more broadly rounded than ventrocaudal, ventral margin evenly convex. Caudal margin of mesonotum slightly convex dorsad, of metanotum truncate.

LEGS.—Minutely setose. Cephalic femur 1.73 (1.55-1.8) times length of pronotum; ventrocephalic carina with 1, 1 (1-3) subdistal spurs .6 (.3-.7) times as long as breadth of femur at point of insertion. Cephalic metatarsus as long as proximal breadth of clypeus. Middle femur with 0, 2 (0-4) spurs on ventrocephalic carina; caudal face with short genicular spur and 2, 3 (0-4) small to minute spurs on ventral carina. Dorsal spurs of middle tibia shorter than depth of tibia. Caudal femur slender, proximal portion moderately enlarged, sides tapering gradually to distal fifth, thence subparallel; length 4.1 (3.9-4.3) times greatest breadth, 3.31 (3.15-3.52) times length of pronotum, 1.92 (1.85-2.06) times that of cephalic femur; ventrocephalic carina nearly straight, narrowly and uniformly explanate, armed with 25, 24 (21-40) small subequal denticulations irregularly spaced, the largest slightly larger than those of caudal tibia; ventrocaudal carina with 32, 36 (20-45) denticulations; caudal genicular lobe minutely denticulate (in half the specimens of each sex); surface denticles on upper half of subdistal two-fifths of femur about 45 (0-55, mode 15); dark parts of scalariform pattern closely and minutely setose. Caudal tibia straight, just appreciably sinuate proximad, slender; 1.21 (1.12-1.23) times length of caudal femur; dorsal spurs slender, of moderate length, apex gently curved, acuminate, outer face sparsely setose, dorsal surface bicarinate; subdistal spur of cephalic carina 1.9 (1.7-2.) times as long as depth of tibia; intervals between spurs averaging more than twice spur length; spine

formula of cephalic carina 11/8/7/6/7, 7/7/7/5/5; calcars short, the dorsocephalic .7 (.5-.75) times and dorsocaudal .8 (.7-.85) times dorsal length of caudal metatarsus; subdistal ventral spurs 2, 2 (1, 2; 1, 1). Caudal tarsus slender, .41 (to .44) times length of caudal tibia; dorsal length of metatarsus 3.2 mm., 2.7 (2.4-2.9) times length of eye; second segment 1.3 mm., 2.2 (2.-2.3) times as long as broad; fourth segment 1.7 mm., 1.75 (1.7-2.) times length of eye; claws .43 (.4-.45) times as long as fourth segment.

TERMINAL ABDOMINAL STRUCTURES.—Seventh and eighth tergites weakly tectate dorsad. Caudal margin of seventh tergite truncate, of eighth broadly arcuate. Mesal portion of caudal margin of ninth tergite subquadrately produced; apex truncate-emarginate, projecting beyond eighth a distance slightly less than exposed breadth of the latter; dorsolateral portions of ninth tergite largely hidden by eighth. Epiproct weakly sclerotized, broad, depressed mesad, joined without obvious demarcation to broadly triangular suranale, the two together pentagonal in outline. Paraprocts largely membranous, unspecialized. Cerci slender, unusually elongate, 1.27 (1.18-1.3) times length of pronotum. Pseudosternite distinctive; dorsolateral auriculae in caudal aspect triangular with bluntly pointed admesal apices, subvertical mesal faces, and gradually declivent, nearly straight outer margins; each lobe strongly triquetrous with concavoplanate caudal and mesal faces and narrowly triangular, transverse, deeply excavate dorsal surface; auriculae separated by a deep narrow trough with overhanging walls, its floor concave and projecting beyond caudal faces of lobes so as to overhang concavity of pseudosternite arch; cephalic lobe paraboloid, narrower and more elongate than that of *brevipes*. Subgenital plate small, shallow; in caudal aspect suboval; distal portion with a pair of swollen arcuate-divaricate ridges more heavily sclerotized than rest of plate, widening distad and terminating as distolateral angles of plate, together outlining a rounded V shaped distomesal area with depressed submembranous floor, divided by median sulcus, the latter evanescent proximad of junction of ridges; distal margin subtruncate; margins adjacent to median sulcus weakly produced as bluntly triangular but scarcely digitate projections; proximolateral plates separated by distinct sulcus, their narrowly rounded apices separated by membranous areas from proximal portion of free margin. Penial setae differing strongly from those of *brevipes*, which are strongly curved, broad bladed falcate structures with distinctly fluted shafts; in *williamsoni* the most specialized are short shafted, the shafts with lateral

flanges but rarely fluted, the distal blade abruptly bent, commonly at about right angles to the shaft, narrowly pointed; a large proportion of the rest of the penial setae stout and flask shaped at the base, abruptly tapering distad into elongate, straight or sinuate flagelliform apices.

ALLOTYPE—FEMALE

GENERAL.—Onondaga cave, Crawford county, Mo.: Sept. 15, 1930, Hubbell, *MMZ*. Length of body exclusive of ovipositor 17.3 mm.

LEGS.—Cephalic femur 1.53 (1.47-1.64) times as long as pronotum; ventrocephalic carina with 2, 1 (1-3) spurs. Middle femur with 2, 2 (1-4) spurs on ventrocephalic carina; caudal

CEUTHOPHILUS WILLIAMSONI—MEASUREMENTS IN MILLIMETERS

	Length of pro- notum	Length of cephalic femur	Length of caudal femur	Breadth of caudal femur	Length of caudal tibia	Length of ovi- positor
MALE						
Onondaga cave, Mo.*....	4.8	8.3	15.9	3.9	19.3	....
Onondaga cave, Mo.....	4.6	7.3	14.4	3.7	16.9	....
Onondaga cave, Mo.....	4.7	8.	16.5	4.	19.3	....
Short Bend cave, Mo.....	3.8	6.4	12.6	3.1	14.5	....
Short Bend cave, Mo.....	4.2	7.5	13.9	3.5	16.7	....
Lesterville cave, Mo.....	3.8	6.7	12.9	3.1	15.7	....
Dubois, Ill.....	4.4	7.9	15.5	3.5	18.4	....
FEMALE						
Onondaga cave, Mo.**...	4.7	7.2	14.8	3.8	17.5	9.9
Onondaga cave, Mo.....	4.4	6.7	13.4	3.6	15.3	9.1
Onondaga cave, Mo.....	5.4	8.4	16.5	4.3	19.3	11.1
Short Bend cave, Mo.....	4.5	7.3	14.	3.6	16.3	9.4
Short Bend cave, Mo.....	5.	8.	16.1	4.	19.	10.1
Lesterville cave, Mo.....	3.9	6.2	12.7	3.2	14.9	8.2
Little Rock, Iowa.....	5.6	....	....	....	....	10.4

*Holotype. **Allotype. Antennae of both are 65 mm. long.

face with genicular spur and 3, 3 (0-5) spurs on ventral carina. Caudal femur/pronotum ratio 3.15- (2.93-3.26); caudal femur/cephalic femur ratio 2.06 (to 1.92); caudal femur length/breadth ratio 3.9 (3.54-4.15). Caudal femur with 22, 23 (20-39) small denticulations on ventrocephalic carina; ventrocaudal carina with 21, 23 (15-44) similar denticulations; dorsal surface with 9, 5 (0-21) denticles. Caudal tibia straight, 1.18 (1.1-1.22) times as long as femur; spine formula of cephalic carina 9/11/6/7/4, 10/8/7/6/4. Caudal tarsus as in male except that the second segment is 2.5 times as long as broad.

TERMINAL ABDOMINAL STRUCTURES.—Cerci slender, elongate, 1.17 (1.1-1.21) times as long as pronotum. Subgenital plate

simple. Ovipositor 2.1 (1.79-2.16) times as long as pronotum; almost straight, slender and gradually tapering from base; apices of dorsal valves slightly upturned, acuminate but not prolonged; ventral valves armed in distal .22 (.18-.25) with five acute, narrowly triangular teeth (including decurved distal hook), the interval between the proximal pair distinctly greater than remaining intervals.

GENERAL NOTES ON THE SPECIES

COLORATION.—Dorsum generally ochraceous buff to cinnamon brown, transversely fasciate with darker brown; caudal portions of abdomen often suffused with brownish. Antennae buckthorn brown to clay color, darker at base. Head warm buff to cinnamon buff ventrad; vertex antimony yellow to clay color, with four slender ramose lines breaking up into a network of fine brownish lines. Eyes dark. Disk of pronotum largely cinnamon buff to clay color, more or less variegated with brownish; bordered cephalad and caudad with broad bands of bister, ventral margins bordered with dilute warm sepia to dilute bister; cephalic marginal bands sending back on each side of the meson a stripe of bister which nearly attains apices of triangular admesal expansions of caudal marginal band, the mesal margins of these stripes often dilute, sometimes intensive and nearly obliterating median pale hairline. Meso- and metanotum bordered caudad and ventrad with broad marginal band of bister, mummy brown or blackish sepia about half as wide as exposed breadth of tergites, often dilute along ventral margin; rest of surface, including a few small maculae enclosed in marginal bands, cinnamon buff to clay color. Caudal margins of abdominal tergites broadly bordered by blackish bister to blackish sepia, the dark areas more or less broken by many small pale maculae, or nearly solid; even the ventral margins of the tergites dilute brownish. Cerci cinnamon buff to sayal brown. Venter, proximal and internal surfaces of cephalic and middle femora, distal portions of all tibiae and all tarsi light ochraceous buff to cinnamon buff; genicular portions of cephalic and middle legs lightly suffused with brownish. Caudal femur cinnamon buff to clay color proximad, scalariform pattern distinct in this portion, Dresden brown to sayal brown, distad becoming lost in a general suffusion of that shade. Genicular lobes and base of caudal tibia slightly darkened; caudal tibia nearly unicolorous light ochraceous buff, cinnamon buff or clay color; spurs and spur bases not notably lighter, as is normal in *brevipes*.

VARIATION.—The species appears to be relatively constant

in its more important characters. Spine formula of cephalic carina of caudal femur, as determined from 62 adult legs and 76 legs of last three nymphal instars: range 7-15/5-11/4-10/3-8/1-7, mode 11/7/7/6/5. In 39 adults and 43 late instar nymphs the subdistal ventral spurs of the caudal tibiae vary as follows: 1, 1, 22%; 1, 2, 43%; 2, 2, 34%; 2, 3, 1%. In *Ceuthophilus* the middle tibiae normally possess 2 spurs upon each dorsal carina; nine of the 39 adult specimens of *williamsoni* deviate from this condition by the loss or addition of a single spur upon one or several of these margins. This is an unusually high degree of variability in this feature, a characteristic of the species which is also found in *brevipes*. No tendency toward increase in number of ovipositor teeth such as is found in *brevipes* is indicated in the series studied.

LIFE HISTORY.—The species apparently matures over an extended period, for although an adult male was taken at Dubois, June 3, the series obtained at Krapf cave, Mo. by Williamson on August 18 contained no adults, and the species was apparently just reaching maturity at Onondaga cave on September 6, 7. At the latter locality adults had become numerous by September 15. The Krapf cave material was studied in detail; it apparently represents six preadult instars, the largest specimens being in the penultimate stadium. Nymphs of *williamsoni* may be distinguished from those of most of the other species occurring within its range by the slender legs and multidenticulate carinae of the caudal femur; in general appearance they resemble those of *gracilipes*, but seldom show any trace of the pale pregenicular annulus usually present on the caudal femur in the latter species.

HABITAT.—The greater part of the series here recorded was obtained in and about the mouths of limestone caves in the Ozark uplands. At Onondaga cave the species occurred in rock piles and about stone walls on the openly wooded slopes above the cave mouth; it was common in the entrance chamber of the cave where the nymphs were for the most part on the floor and walls, the adults on the ceiling; and attendants stated that occasional specimens had been seen several hundred yards within the cave. Williamson found it abundant in the entrance of Krapf cave and specimens were collected in other Missouri caves by Creaser and Clanton. Two small nymphs dubiously referred to *williamsoni* were obtained by Garman in a cave on the Ohio river in southern Illinois. The situations in which the Iowa specimens and the male from Dubois, Ill. were taken are not known.

C. williamsoni is not an obligatory cavernicole, but is probably

a rock loving species inhabiting open forests and taking refuge in caves and similar shelters wherever they are available, as does *brevipes* in Indiana and Kentucky. In Onondaga, Short Bend and Krapf caves it appeared to be the only species present, but in Lesterville cave it was outnumbered by *C. gracilipes*. A trip made to Dubois, Ill. in hope of obtaining additional material resulted in the capture of *maculatus*, *uhleri* and great numbers of *divergens* in molasses traps set in oak-hickory upland woods, but *williamsoni* was not encountered.

DISTRIBUTION.—The Ozark plateau appears to be the center of distribution of this species, from which region it extends northward in the prairie-plains to Little Rock and McGregor, Iowa, and crosses the Mississippi into southernmost Illinois. Its range borders that of *brevipes* on the west, but the two species are not known to come into contact.

One hundred sixty-six specimens were examined, 17 ♂, 25 ♀ (holotype, allotype and paratypes) and 124 immatures, as follows:

ILLINOIS.—**Dubois:** June 3, 1919, 1 ♂. **Cave** on Ohio river: July 27, 1883, 2 juv. ♂, approximately third instar, Garman, determined with doubt.

IOWA.—**Little Rock,** Lyon county: 1 ♀, determined by Scudder in 1896 as *seclusus*, *ISC*. **McGregor,** Clayton county: July 13, 1904, 1 juv. ♂ in last instar, Wolcott.

MISSOURI.—**Cave** 1.5 miles northeast of Lesterville, on west bank of east fork of Black river, Reynolds county: Oct. 17, 1933, 1 ♂, 1 ♀, on roof of pocket at side of large room 100 ft. from entrance, Clanton, *MMZ*. **Cave** 2.5 miles southeast of Windyville, Dallas county: Aug. 20, 1930, 1 large juv. ♂, Creaser, *MMZ*. **Krapf cave,** near Waynesville, Pulaski county: Aug. 18, 1929, 52 juv. in all instars, Williamson, *MMZ*. **Onondaga cave,** 5 miles south of Leasburg, Crawford county: Sept. 6-15, 1930, 12 ♂, 19 ♀, 16 large juv. ♂, 15 large juv. ♀, 34 small juv. ♂♀, Hubbell, *MMZ*. **Rocheport,** Boone county: July 4, 1 juv. ♂, 2 juv. ♀ in fourth or fifth instar, Wolcott, *ANS*. **Short Bend cave,** bank of Meramec river, 1 mile northeast of Short Bend, Dent county: Oct. 14, 1933, 3 ♂, 4 ♀, Clanton, *MMZ*.

C. uhleri Scudder.

- 1862 *Ceuthophilus uhleri* Scudder, Bost. Journ. Nat. Hist., vol. 7, p. 435. ♂, ♀, Maryland.
 1920 *Ceuthophilus uhleri* Blatchley, Orth. Northeast. Am., p. 627, fig. 208; pl. VI, fig. c; pl. VII, fig. o.
 1931 *Ceuthophilus uhleri* Hubbell in Hebard, Proc. Acad. Nat. Sci. Phil., vol. 83, p. 206. Synonymy, statement of range.

Although not previously recorded from Illinois, *Ceuthophilus uhleri* is apparently one of the commoner species in the forests of the southern two-thirds of the state. The species is evidently limited west-

ward by the treeless plains, but pushes far out into the prairie region along the stream-margin forests of Iowa and Kansas.

R. I. C. (Rock Island county): 1 juv. ♂, 1 juv. ♀, McNeill, *MCZ*. **Martinsville:** Aug. 8, 1929, 62 juv., Hubbell, *MMZ*. **Dubois:** Aug. 9, 1929, 106 juv., Hubbell, *MMZ*.

***C. divergens* Scudder.**

1862 *Ceuthophilus divergens* Scudder, Bost. Journ. Nat. Hist., vol. 7, p. 436. ♂, ♀, Nebraska.

1920 *Ceuthophilus caecus* Blatchley, Orth. Northeast. Am., p. 637; pl. VI, fig. i; pl. VII, figs. h, s. In part.

1931 *Ceuthophilus divergens* Hubbell in Hebard, Proc. Acad. Nat. Sci. Phil., vol. 83, pp. 205-206. Synonymy, statement of range.

Judging by the number of times it has been collected this species appears to be the commonest member of the genus in Illinois. There are no published records of its occurrence in this state, but there is reason to believe that the references to *Ceuthophilus* species by Hart (1907), Vestal (1913) and Adams (1915) are more than likely to have been based upon specimens of *divergens*.

Savanna: July 22, 1892, 1 ♂, Hart and Forbes. **Palos Park:** June 20, 1933, 1 ♂, 1 ♀, Ross and Mohr. **R. I. C. (Rock Island county):** June 15, 1 juv. ♂, McNeill, *MCZ*. **Havana:** May 2, 1912, 1 ♂ in flood drift in Spoon river; Aug. 14, 1907, 2 ♂ on river shore. **Muncie:** June 14, 1907, 2 ♀. **Homer:** June 21, 1907, 1 juv. ♂ in park. **Urbana:** June 9, 1889, 1 juv. ♂; Aug. 12, 1885, 1 ♀. **Mahomet:** June 30, 1912, 1 ♀ on shore of Sangamon river. **Martinsville:** Aug. 8, 1929, 24 ♂, 44 ♀, Hubbell, *MMZ*. **Grafton:** Aug. 26, 1905, 1 ♂. **Dubois:** June 21, 1905, 3 ♂, 4 ♀, 1 juv. ♀; Aug. 9, 1929, 234 ♂, 285 ♀, Hubbell, *MMZ*. **Chester:** July 30, 1905, 1 ♂, 1 ♀. **Parker:** June 12, 1907, 1 juv. ♀.

***C. elegans* Hubbell. NEW SPECIES.**—This is a small compact species with a robust fusiform body, yellowish brown and usually with exposed margins of tergites infuscated to form a strongly contrasted dorsal pattern, and short stout legs.

It is practically indistinguishable from dark colored eastern material of the great plains species *C. fusiformis* Scudder, except by means of the uniquely specialized pseudosternite of the male. No character has been found to separate females of the two species. *C. elegans* cannot be confused with any other species east of the Mississippi except *occultus*; but the latter is smaller and paler, its known range lies east of Illinois, and the male has a strikingly bicristate pseudosternite arch instead of a median process. *C. silvestris* Bruner, occurring from Minnesota to Kansas and Arkansas, is very similar to *elegans*, but like *occultus* has a bicristate pseudosternite and is normally paler.

HOLOTYPE—MALE

GENERAL.—Madison, Dane county, Wis.: May 1915, Mar-

shall, *MMZ*. Length of body 10.3 mm. Dorsum polished, subglabrous.

HEAD.—Fastigium with broadly conical apex, in lateral aspect slightly more prominent than expanded mesal margins of antennal fossae; dorsal surface depressed, strongly declivent. Eyes small, not prominent, broadly subpyriform, length .8 mm., ratio length/breadth 1.1 (to 1.25). Interocular space 1.56 (to 1.4) times as long as eye. Antennae short, approximately 3.1 times as long as the short caudal femur. Distal segment of maxillary palpus 1.4 (to 1.1) times as long as interocular space.

THORAX.—Surface smooth, foveolae scarcely impressed. Pronotum broad, in lateral aspect three-fourths as high as length of dorsum; sides moderately convergent ventrad, ventrocephalic angle more broadly rounded than ventrocaudal, ventral margin evenly convex. Caudal margin of mesonotum slightly convex dorsad, of metanotum truncate.

LEGS.—Minutely setose. Cephalic femur 1.09 (to 1.19) times length of pronotum; slightly stouter than middle femur; ventrocephalic carina with 1, 1 (1-3) subdistal spurs .25 (.1-3) times as long as breadth of femur at point of insertion. Cephalic metatarsus .5 (to .7) times as long as proximal breadth of clypeus. Middle femur with 2, 3 (2-5) spurs on ventrocephalic carina; caudal face with a very short genicular spur and 2, 3 (1-5) small spurs on ventral carina. Dorsal spurs of middle tibia about a third as long as depth of tibia. Caudal femur short, stout, grylloid; base moderately enlarged and sides tapering to base of genicular lobes with scarcely an indication of the usual pregenicular constriction; length 2.76 (2.5-3.1) times greatest breadth, 2.24 (to 2.52) times length of pronotum, 2.04 (2.-2.17) times that of cephalic femur; ventrocephalic carina narrowly and uniformly explanate, armed with 34, 31 (18-48) small subequal denticulations; ventrocaudal carina with 33, 33 (18-54) similar denticulations; caudal genicular lobe minutely denticulate (cephalic lobes less conspicuously so in about two-thirds of the specimens); dorsal surface with 5, 8 (0-12) small denticles. Caudal tibia straight; 1.05 (1.-1.12) times as long as caudal femur; dorsal spurs rather short, moderately slender, gently curved, apex minutely hooked, outer face sparsely setose, dorsal surface bicarinate (outer carina sometimes faint or abbreviate); length of subdistal spur of cephalic carina 1.4 (to 1.8) times depth of tibia; spine formula of cephalic carina 8/5/5/6/5, 7/4/5/5/5; calcars short, the dorsocephalic .93 (.8-1.) times and dorsocaudal 1. (.94-1.15) times dorsal length

of caudal metatarsus; subdistal ventral spurs 1, 1 (rarely 0, 1; 0, 0). Caudal tarsus short, stout; .43 (.39-.45) times length of caudal tibia; dorsal length of metatarsus 1.75 (1.67-1.83) times as long as eye; second segment 1.6 (1.5-1.8) times as long as its depth; claws .43 (to .5) times as long as fourth segment; ventral carina of metatarsus with a row of short stout setae extending at least halfway to apex.

TERMINAL ABDOMINAL STRUCTURES.—Caudal margins of first six abdominal tergites truncate, of seventh weakly rounded-angulate dorsad. Dorsal portion of eighth strongly produced, projecting portion overhanging genital cavity and concealing dorsal portion of ninth tergite; sides of projection arcuate-convergent to apical truncation about three-fifths as broad as interocular space, margin of truncation thickened and membranous, shallowly emarginate in dried material. Caudal margin of eighth tergite oblique in lateral aspect, broadly concave, extending in an almost regular curve to the lateral angles of apical truncation (roundly angulate in *occultus* and *silvestris*). Ninth tergite shaped like eighth but smaller; dorsal truncation membranous at edge, underlying same portion of eighth. Truncations of eighth and ninth tergites strongly convex upward in caudal aspect. Epiproct largely membranous, its distal portion in dried material usually compressed between dorsal edges of paraprocts, with sides slightly elevated, straight and convergent to the narrowly rounded, acute-angulate apex; in dried material surface usually impressed or sulcate. Suranale broadly triangular, abruptly deflexed. Pseudo-sternite a flattened arch, in caudal aspect subtriangular; concavity of arch small, occupied with membrane; broad ventrolateral arms with sides nearly straight and convergent dorsad, continuing without interruption as margins of short paraboloid cephalic lobe; dorsum of arch uniquely specialized, furnished with a caudally directed, vertically compressed median process laminate at apex, appearing acuminate in dorsal aspect and distally rounded in lateral aspect, its surfaces and margins minutely asperate. Subgenital plate small, weakly sclerotized; in caudal aspect subtriangular and more or less tectate; broadest proximad, sides thence nearly straight and convergent to narrowly rounded admesal apices which are separated by a narrow mesal cleft or emargination extending but a short distance into the plate; in lateral aspect subtriangular with narrowly rounded apex, straight dorsal margin and angulately convex ventral outline; proximolateral plates triangular, set off by distinct sulci. Penial setae reduced in number, small; the most specialized short, about twice as broad in caudal as in

lateral aspect because of flaring lateral expansions with broadly arcuate margins, their sides convergent toward apex, which is a short, acute, vertically laminate point bent abruptly at more or less than a right angle to shaft; between this extreme and the simple, short, curved, acuminate lateral setae all intergradations occur.

ALLOTYPE—FEMALE

GENERAL.—Madison, Dane county, Wis.: May 1915, Marshall, *MMZ*. Length of body exclusive of ovipositor 10.4 mm. Similar in size and proportions to male, and indistinguishable from female of *fusiformis* by any well defined characters.

CEUTHOPHILUS ELEGANS—MEASUREMENTS IN MILLIMETERS

	Length of pro- notum	Length of cephalic femur	Length of caudal femur	Breadth of caudal femur	Length of caudal tibia	Length of ovi- positor
MALE						
Ames, Iowa.....	3.1	3.4	7.1	2.5	7.9	...
Ames, Iowa.....	3.6	4.3	9.	3.2	9.8	...
Madison, Wis.*...	4.2	4.6	9.4	3.4	9.9	...
Madison, Wis.....	4.4	4.9	10.5	3.8	10.6	...
Mayview, Ill.....	3.1	3.7	7.8	2.6	8.1	...
Southern Ill.....	3.7	4.3	8.6	3.4	9.6	...
Lafayette, Ind.....	2.8	3.1	6.3	2.1	7.	...
Lafayette, Ind.....	3.8	4.5	9.4	3.3	10.3	...
FEMALE						
Ames, Iowa.....	2.8	3.1	6.1	1.9	7.	3.8
Ames, Iowa.....	3.3	3.6	7.	2.4	7.5	4.3
Ames, Iowa.....	3.8	4.4	9.1	3.	9.9	4.8
Madison, Wis.**...	4.	4.3	8.8	3.1	9.2	4.8
Madison, Wis.....	3.5	3.9	8.1	2.6	8.8	4.4
Urbana, Ill.....	3.6	3.9	8.3	2.8	8.9	4.4
Muncie, Ill.....	3.7	3.9	8.2	2.9	9.	4.4
Normal, Ill.....	4.1	4.6	9.3	3.4	10.4	4.7
Southern Ill.....	3.7	4.2	8.5	3.1	9.5	3.9
*Holotype. **Allotype.						

LEGS.—Cephalic femur/pronotum ratio 1.07 (1.03-1.16); caudal femur/pronotum ratio 2.2 (2.1-2.31); caudal femur/cephalic femur ratio 2.04 (1.83-2.24); caudal femur length/breadth ratio 2.84 (2.74-3.21); caudal tibia/caudal femur ratio 1.04 (to 1.15). Caudal tarsus .39 (to .46) times as long as caudal tibia; metatarsus 1.63 times as long as eye; second segment 1.7 times as long as broad; fourth segment 1.5 times as long as eye; claws .5 times as long as fourth segment. Armature of legs as in male, except middle tibia with less dorsal spurs on all carinae, and caudal legs as follows: *femur*—ventrocephalic carina with 24, 31 (19-45) minute denticulations, ventrocaudal carina with 24, 21

(19-41) similar denticulations, no (to 25) surface denticulations on upper half; *tibia*—spine formula of cephalic carina 7/5/+5/4, 8/7/4/5/5, dorsocephalic calcar 1.07 times and dorsocaudal calcar 1.23 times dorsal length of metatarsus.

TERMINAL ABDOMINAL STRUCTURES.—Cerci slender, .7 times as long as pronotum. Subgenital plate simple. Ovipositor very short, 1.2 (1.05-1.36) times as long as pronotum; stout proximad, tapering rapidly to middle, thence slender and subequal; entire organ slightly upcurved; apices of dorsal valves distinctly upturned and drawn out into elongate, slenderly aciculate points; ventral valves armed in distal .23 (.21-.26) with five elongate, very slender and strongly aciculate, curved teeth (including distal hook), the subapical tooth as long as distal breadth of dorsal valves, intervals between teeth increasing slightly proximad.

GENERAL NOTES ON THE SPECIES

COLORATION.—Dorsum generally yellowish brown, the tergites black bordered and pronotum with a pair of short dark bars projecting backward from cephalic marginal band. Dark portions of the pattern often broad and conspicuous, in maximum intensity spreading over most of dorsum of abdomen, and longitudinal pronotal bars often fused into a quadrate cephalomesal blotch. The average coloration of *elegans* is like that of the darkest eastern material of *fusiformis*, and while the recessive extreme of the latter is wholly pale, unmarked specimens of *elegans* have not been seen and probably rarely if ever occur.

VARIATION.—Aside from differences in size and coloration and in leg armature already treated the species appears to be quite constant. The breadth and exact form of apex of the median process of the pseudosternite vary slightly without affecting the general aspect of the structure. The subdistal ventral spurs of the caudal tibiae are 1, 1 in all except two females, in which the condition is 0, 1 and 0, 0. The ventral valves of the ovipositor of a single female from Ames, Iowa bear six instead of the usual five teeth.

LIFE HISTORY AND HABITAT.—From the available data it appears that adults and nymphs of *C. elegans* occur in every month of the year, adults being most numerous in the fall. The species seems to inhabit both grassland and open forest, the latter being indicated by a label on a specimen from Lafayette, Ind., "taken under logs," and by other evidence. The species is also of common occurrence in cultivated fields. The overlapping of generations noted is probably correlated with its largely sub-

terranean mode of life and consequent ability to pass the winter in various stages—a characteristic shared by the other members of the group to which *elegans* belongs. The most accurate information regarding the species is that furnished by Leroy Hunter, who writes from Tower Hill, Ill.

"I have known this insect for at least 10 years, some being dug up in my garden every year. The garden is located on sandy upland soil at the edge of open woods. The insects are frequently encountered in deserted mole runways, but they also dig holes for themselves, and can even bore into hard clods. They winter in both nymph and adult stages, and are often found in colonies; sometimes as many as 10 nymphs of various sizes and one or two adults are found together. The nymphs in life are bluish gray."

DISTRIBUTION.—The range of *C. elegans* appears to lie entirely within the zone between the deciduous forest region and the plains—the prairie belt. The species is replaced in the great plains by *fusiformis*, from which it has probably been derived. In the prairie region west of the Mississippi its range overlaps that of the more distantly related *silvestris*, and to the east it is replaced by *occultus*, a species related to *silvestris* more closely than to *elegans*. No other species of the group to which it belongs has as yet been found in Illinois.

Forty-five specimens were examined, 19♂, 25♀ (holotype, allotype and paratypes) and 1 juv. ♀, as follows:

ILLINOIS.—**Normal:** Apr. 18, 1881, 1♀. **Urbana:** Mar. 27, 1889, 1♀ in cornfield, Marten; Apr. 9, 1887, 1♂ in pasture, Weed; 1♀. **Mayview:** Oct. 25, 1907, 1♂. **Tower Hill:** Feb. 15, 1934, 1♀ in garden, Hunter, MMZ (additional material in Hunter and Hebard collections). **Southern Ill.:** 1♂, Uhler, MCZ; —? 1♀, Barnes, MCZ.

INDIANA.—**Lafayette,** Tippecanoe county: May 26, 1926, 1♂; Oct. 10-25, 1930, 2♂; Oct. (Dec.?) 8, 1931, 1♂ under logs; PU, MMZ.

IOWA.—**Ames,** Story county: Oct. 22-27, 1891, 8♂, 13♀, 1 juv.♀, ISC, MCZ, MMZ. **Iowa:** 1♂, 2♀, ISC; —? probably Ames, 1♂, ISC.

WISCONSIN.—**Madison,** Dane county: Apr. 4, 1912, 1♀, Marshall; Oct. 10, 1912, 2♀, Marshall; May 1915, 1♂, 2♀, Marshall; Aug. 27, 1915, 1♂, Marshall. All in MMZ and Marshall collections.

Phrixocnemis Scudder

P. truculentus Scudder.—There is the possibility of this species occurring in Illinois, as the type of *P. inhabilis* Rehn, placed by Hebard as a synonym of *truculentus* in 1929, came from St. Louis, Mo.

Udeopsylla Scudder

U. robusta (Haldeman).

1850 *Phalangopsis (Daihinia) robustus* Haldeman, Proc. Am. Ass. Adv. Sci., vol. 2, p. 346. ♀, North America.

1925 *Udeopsylla robusta* Hebard, Proc. Acad. Nat. Sci. Phil., vol. 77, p. 145. Synonymy, distribution.

This large, robust and heavily sclerotized insect reaches its eastern limits of distribution in eastern Illinois, extending thence west to the Rocky mountains in Colorado, Wyoming and Montana, and following the prairie and plains regions south to northern Texas and New Mexico and north to southern Manitoba; it has also been reported from southern Idaho and Utah. Established synonyms are *Marsa arcuata* Walker, *Udeopsylla compacta* Bruner, *U. nigra* Scudder, *Daihinia gigantea* Bruner, *Ceuthophilus politus* Scudder, *C. devius* Scudder, *C. niger* Scudder and *C. ater* Scudder.

The principal Illinois records are as follows: the synonymous *Ceuthophilus niger* was described by Scudder in 1862 from Rock Island, and has been listed as occurring in Illinois by Brunner (1888), McNeill (1891) and others; as *Udeopsylla nigra* it was recorded from Perry county, Rock Island and southern Illinois by Scudder in 1894; and as *U. robusta* it was reported from Bloomington by Thomas in 1878, and from the vicinity of Havana by Hart in 1907; a number of other records from "Illinois" or "eastern Illinois" all seem to be based on these cited above.

Savanna: July 21 and 22, 1892, 1♂, 1♀, at light and at sugar. **Normal:** June 14, 1882, 1♂. **Bloomington:** July 26, 1895, 1♀. **Topeka:** Oct. 28 to 31, 1907, 8 small and 1 medium juv.♂, 4 small juv.♀. **Havana:** May 17, 1894, 1 large juv.♂; Aug. 11, 1907, 1♀. **Devil's Hole:** June 8, 1905, 1♀; June 27, 1907, 1 juv.♀. **Muncie:** Apr. 30, 1905, 1 juv.♂, Hart; June 15, 1905, 1♂, 2♀. **Urbana:** Jan. 9, 1900, 1♂, Woodworth; May 14, 1885, 1 juv.♀ in woods; June 6 to 11, 1906, 9♂, 1 juv.♂, 3♀; June 8, 1933, 1♀, Mohr; June 17, 1885, 1♂, 1♀, under stones; June 20, 1907, 1♂ at light; June 25, 1909, 1♂; July 31, 1906, 1♂ in insectary basement; Oct. 24, 1932, 1♂, Mohr. **Champaign:** July 19, 1912, 1♂, Frison. **Champaign county:** Aug. 4, 1894, 1♂ under ear of green sweet corn in cellar, Johnson. **Quincy:** June 18, 1923, 1♀, Clench, MMZ. **Kampsville:** June 25, 1931, 1♂, Frison, Betten and Ross.

GRYLLIDAE

KEY TO SUBFAMILIES AND GENERA

1. Tarsi compressed. 2
Tarsi with second joint depressed, heart shaped. 11
2. Cephalic tibiae normal, not specialized for digging. Male tegmina distad provided with a speculum. 3
Cephalic tibiae highly specialized for digging, fig. 164, p. 257. Male tegmina lacking a speculum. Ovipositor not exerted. Form cylindrical. 10
3. Surface without scales. Caudal tibiae armed with spines, except *Neoxabea bipunctata*. 4
Surface clothed with scales. Caudal tibiae without spines but with dorsal margins closely serrulate. Head horizontal, with a large interantennal

GRYLLIDAE—KEY TO SUBFAMILIES AND GENERA—CONT'D

- protuberance. Eyes oblique. Ocelli absent. Male pronotum greatly produced caudad with tegmina briefly projecting; female pronotum very short, organs of flight absent. Caudal femora short. Cephalic tibiae with evident auditory foramina on cephalic face only. Ovipositor simple with apex enlarged but unarmed. Form stout. Minute. Red-brown and very dark brown. Terrestrial. (*MOGOPLISTINAE*)....**Cycloptilum**, p. 256
4. Head short, vertical or nearly so, fig. 161, p. 249. Caudal femora stout. Caudal tibiae armed with large spines but lacking teeth between them. Color brown or black.....5
- Head elongate, horizontal, fig. 163, p. 254. Caudal femora very slender. Caudal tibiae with dorsal margins armed with elongate delicate spines with minute teeth between them, or unarmed. Eyes ovate, oblique. Ocelli absent. Organs of flight fully developed. Cephalic tibiae moderately enlarged at the evident auditory foramina. Form elongate. Comparatively small. Structure very delicate. (*OECANTHINAE*, p. 251).....9
5. Organs of flight present. Eyes not reduced. Ocelli present. Caudal femora moderately enlarged. Cephalic tibiae with evident auditory foramina. Form moderately elongate. Small to large.....6
- Organs of flight absent. Eyes greatly reduced. Ocelli absent. Caudal femora enormously enlarged. Cephalic tibiae lacking auditory foramina. Form subspherical. Minute. Ovipositor tubular with apices of valves diverging and specialized. Brown. Inhabits the nests of ants. (*MYRMECOPHILINAE*).....**Myrmecophila**, p. 257
6. Caudal metatarsus flat above with a row of very small teeth on each side. Caudal tibiae armed dorsad with fixed spines which are shorter and glabrous. No large bristles present on body or legs. Medium to large. (*GRYLLINAE*, p. 246).....7
- Caudal metatarsus rounded above, unarmed but hirsute. Caudal tibiae armed with movable spines which are elongate and velutinous. Large bristles present on body and legs. Small. (*NEMOBIINAE*)....**Nemobius**, p. 247
7. Caudal tibiae with inner dorsal spur shorter than inner mesal spur. Ovipositor fully exerted. Fastigium twice as wide as proximal antennal joint or wider.....8
- Caudal tibiae with inner dorsal spur longer than inner mesal spur. Ovipositor vestigial, projecting briefly beyond apex of subgenital plate. Fastigium less than twice as wide as proximal antennal joints. Large in comparison. Reddish brown or reddish buff. Tegmina definitely transparent.....**Anurogryllus**, p. 247
8. Caudal tibiae with usually more numerous (five to eight) spines on each dorsal margin. Male tegmina with three to six transverse veins. Larger.....**Gryllus**, p. 246
- Caudal tibiae with usually fewer (four to six) spines on each dorsal margin. Male tegmina with normally two, occasionally one to three, transverse veins. Females brachypterous. Black to dark brown, in all but the darkest individuals occiput marked proximad with pale longitudinal lines. Medium size.....**Miogryllus**, p. 246
9. Caudal tibiae with dorsal margins armed with elongate delicate spines having minute teeth between them; apex with three pairs of spurs. Proximal

GRYLLIDAE—KEY TO SUBFAMILIES AND GENERA—CONT'D

- antennal segment without a rounded projection distad on ventral surface. Pronotum showing little specialization. Wings little if any longer than tegmina. General coloration whitish or very pale green. In dried specimens the general coloration is usually buffy. In life *niveus* is whitish with scarcely any green, the other species being a very delicate pale green.....**Oecanthus**, p. 251
- Caudal tibiae with dorsal margins unarmed; apex with two pairs of spurs. Proximal antennal segment with a prominent rounded projection distad ventral surface. Pronotum impressed mesad, elevated broadly along caudal margin, this area bounded cephalad and caudad by carinae and with series of short ridges crossing it. Wings very much longer than tegmina, the latter very narrow in the male. General coloration buffy, weakly to strikingly marked with brown. Prefers vines and thick undergrowth foliage in woods.....**Neoxabea**, p. 254
10. Tarsi three segmented. Antennae with very many segments. Two large ocelli present. Body hirsute. Large. Subterranean; nocturnal. Generally dull brown. (**GRYLLOTALPINAE**).....**Gryllotalpa**, p. 257
- Cephalic and median tarsi two segmented, caudal tarsi consisting of a single segment or absent. Exceedingly small. Antennae with fewer (11) segments. Body smooth. Live along the margins of bodies of water. (**TRIDACTYLINAE**).....**Tridactylus**, p. 258
11. Caudal tibiae armed with elongate delicate spines but lacking teeth between them and without inner ventrodistal spur. Ovipositor compressed and distinctly upcurved with dorsal and ventral margins serrate at apex. Form moderately robust. Small. (**TRIGONIDIINAE**, p. 255).....12
- Caudal tibiae armed with large spines with minute teeth between them, and with the usual three pairs of distal spurs. Ovipositor cylindrical, apex with ventral surface alone armed with blunt projections. Medium size. (**ENEOPTERINAE**, p. 255).....14
12. Pale and not brilliantly colored. Palpi with last segment cone shaped, not greatly expanded, figs. 101, 102. Interantennal space equal to or slightly wider than the broader first antennal segment. Pronotum in dorsal aspect decidedly wider than long.....13
- Coloration brilliant; black, bright red-brown, white and sometimes Indian red. Palpi with last segment greatly expanded, fig. 100, with sides convex divergent, apex truncate and dorsal surface concave. Interantennal space over twice as wide as the narrower first antennal segment. Pronotum in dorsal aspect as long as wide. Prefers vegetation near ground in damp situations.....**Phyllopalpus**, p. 255
13. Palpi with last segment elongate, expanding very gradually, fig. 102. Interocular area ascending strongly to the rounded occiput. Eyes vertical. Straw colored with facial markings and external surface of caudal femora with a suffused longitudinal brown line. Prefers vegetation near ground in damp situations.....**Anaxipha**, p. 255
- Palpi with last segment short, expanding very strongly, fig. 101. Interocular area horizontal and in same place as occiput. Eyes horizontal. Very pale green in life, dried specimens usually buffy. Inhabits deciduous forest foliage.....**Cyrtoxipha**, p. 255
14. Cephalic tibiae with an evident foramen on cephalic face only. Form robust, short. Head and pronotum with dorsal surface slightly more convex.

GRYLLIDAE—KEY TO SUBFAMILIES AND GENERA—CONCL'D

- Tegmina normally not surpassing apex of abdomen; of female more coriaceous, of male with fewer branches of mediastine vein. Wings not projecting. Ovipositor slightly shorter than caudal femur. Usually dark brown. Prefers vegetation in damp situations.....**Hapithus**, p. 255
- Cephalic tibiae with evident foramina on both faces. Form more elongate. Head and pronotum with dorsal surface less convex, subdeplanate. Tegmina surpassing apex of abdomen; of female more delicate, of male with numerous branches of mediastine vein. Wings projecting briefly beyond tegmina. Ovipositor longer than caudal femora. Light brown, sometimes marked with darker brown. Prefers vines and trees; probably entirely nocturnal.....**Orocharis**, p. 256

GRYLLINAE

Gryllus Linnaeus

KEY TO SPECIES

- Dark brown or black. Head not barred.....**assimilis**
- Straw colored. Head with a dark bar between the eyes and another between the antennal sockets. Introduced, domiciliary.....**domesticus**

G. assimilis Fabricius.—This ubiquitous cricket is represented by a series of 318 specimens from all parts of Illinois showing all graduations from phase *neglectus* to phase *luctuosus* and varying from very small to large for the species. Strong tendency toward phase *scudderianus* is shown however in a series from West Havana, and one female is typical of that phase, which is, we believe, a response to a sandy environment.

The smallest examples are from Beach, Oakwood, Muncie and Homer; the largest from Carbondale, Anna and Pulaski. Immediate environment more than geographic distribution has however been found by us to influence the size development in this very plastic insect.

McNeill in 1891 recorded this species from Illinois as the synonyms *luctuosus*, *vernalis*, *pennsylvanicus* and *abbreviatus*.

G. domesticus Linnaeus.—McNeill reported this insect from Moline and Urbana in 1891. The present material shows that it had reached inland as far as Illinois as early as 1877. Its distribution in the United States has since that date become much more extensive and more general in the east. It is the common European house cricket.

Chicago: Oct. 12, 1920, 1♀, Gueret, *FM*. **Antioch:** July 8, 1932, 1 large juv. ♂, Frison. **Joliet:** Aug. 7 and 12, 1925, 5♀, 3 large juv. ♂, 2 large juv. ♀, 1 very small juv. **Peoria:** Dec. 1, 1932, 1♂, 2♀, in city dump. **Mackinaw Station:** Apr. 22, 1880, 1♀. **Normal:** Oct. 16, 1877, 1♂ in house. **Urbana:** Dec. 14 and 18, 1928, 1♂, 1♀, in house.

Miogryllus Saussure

M. verticalis (Serville).—This insect is limited to the southern half of Illinois, Muncie and Urbana being northernmost records. In

the northern portions of its distribution it evidently appears adult early in the season and in Illinois may well be called a species of the late spring. Almost all of the adults here recorded were secured in June.

Considerable size variation is shown in the material, the series averaging small for the species. The majority of the males are dark.

Twenty-seven males and 42 females, taken June 9 to July 19, and six immatures are from **Muncie, Homer, Urbana, Cerro Gordo, East St. Louis, Dubois, Shawneetown, Carbondale, Grand Tower, Prospect Hill, Alto Pass, Anna, Elizabethtown, Whitehill, Pulaski.**

Anurogryllus Saussure

A. muticus (DeGeer).—This record is based upon only one brachypterous male labeled "Illinois."

This specimen, evidently collected many years ago, is much the smallest we have ever seen of this interesting species, widespread in the southeastern United States and through the American tropics. It is nocturnal, exceedingly rapid in its movements, and its song is loudest of the crickets found in the United States.

The present individual probably came from extreme southern Illinois and furnishes a northwestern limit record. It measures: length of body 12 mm., length of pronotum 2.7 mm., length of tegmen 8.7 mm., length of caudal femur 8.8 mm.

NEMOBIINAE

Nemobius Serville

KEY TO SPECIES

1. Caudal tibiae with the very small pair of ventral apical spurs unequal in length.
Ovipositor longer, the apex armed with very fine teeth.....2
Caudal tibiae with the very small pair of ventral apical spurs equal in length.
Ovipositor short for genus, its teeth very heavy, figs. 118, 119.....8
2. Ovipositor nearly rigidly straight, as long as or longer than the caudal femur..3
Ovipositor very gently curved dorsad, about two-thirds as long as caudal femur.....7
3. Ovipositor with dorsal margin of apex armed with not very sharp teeth, fig. 125.
Size medium to large for genus.....4¹¹
Ovipositor with dorsal margin of apex armed with very sharp teeth, fig. 115,
which can however be worn down by use.....5
4. Occiput with pale longitudinal markings. Dorsal field of male tegmina slightly narrower, not strikingly margined with paler. General coloration brown, often very dark. Tegmina normally showing less distal truncation. Field inhabitant.....**fasciatus fasciatus**, p. 248
Occiput immaculate. Dorsal field of male tegmina slightly broader, often margined laterad with a fine but conspicuous whitish line. General coloration

¹¹The races of *fasciatus* here treated are subject to so much individual variation that they cannot be safely separated by a key.

NEMOBIUS—KEY TO SPECIES—CONT'D

- brown, usually with a clear reddish tint like lacquer. Tegmina showing definite distal reduction. Forest inhabitant. **fasciatus tinnulus**, p. 249
5. Ovipositor as long as caudal femur, with rather heavy apex. Form robust. Medium size. Dark brown maculate with piceous, a pale yellowish suffusion about eyes except ventrad, no other striking markings on head. Tegmina showing definite distal truncation. Forest inhabitant. . . . **maculatus**, p. 249
Ovipositor usually much longer than caudal femur. Form more slender. Medium to small. Peculiar to sand areas. 6
6. Light dark brown with suffusions of grayish, face black or blackish brown and occiput with striking longitudinal markings. **griseus griseus**, p. 249
Much darker, generally black, markings usually obsolete.
 **griseus funeralis**, p. 250
7. Clay color, mottled and flecked with dark brown; face very dark, occiput usually with a transverse dark area. Ovipositor with teeth normal. Medium to medium large. **bruneri**, p. 250
Blackish brown, sometimes somewhat paler, females of the latter phase with dorsal surface of abdomen with paler spots. Ovipositor with teeth exceedingly fine and closely set, fig. 124. Small to very small.
 **cubensis palustris**, p. 250
8. Palpi yellowish with apex of last segment darkened. Rather pale shining brown, usually with a reddish tinge; dorsal surface of female abdomen with paler spots. Ovipositor with teeth very heavy for genus, fig. 118. Medium size. Prefers woodland borders. **carolinus carolinus**, p. 251
Palpi white, immaculate. Shining blackish brown, dorsal surface of female abdomen immaculate. Ovipositor with even heavier teeth, fig. 119. Small. Prefers deep damp woods. **confusus**, p. 251

N. fasciatus fasciatus (DeGeer).—Five hundred and six specimens of this very common cricket are before us from all parts of Illinois.

In the north the series average very dark with pale markings usually present and sharply defined though often much reduced. Apparently only in sandy areas is a condition frequently encountered which is characterized by its more robust form and decided pallidity. This local adaptation grades into the typical so generally that it should not be recognized by name. It is the extreme of the condition shown by *canus*, described by Scudder from Dallas, Tex., a name placed by us in synonymy under *fasciatus socius* in 1913. Seventy-three such specimens are before us, the very pallid of these numbering 29, from Savanna, Moline, Meredosia, Quincy, Clay City, Dubois, Anvil Rock Hills, Williams Mountain.

We do not agree with Fulton (1931) who believes that *fasciatus socius* represents an ecological rather than a geographic race. It differs from typical *fasciatus* mainly in having the ovipositor as long as to slightly shorter than the caudal femur, but we do admit that it may not be sufficiently distinguished to warrant nominal recognition. If recogniz-

able it certainly constitutes a southern geographic race. In the present series a very few females in the large series from Urbana have the ovipositor almost as short as the caudal femur. In 11 females from Cairo however this is the rule, a few having it no longer than the caudal femur, as in one specimen in a series from St. Louis recorded by us in 1913.

If *fasciatus socius* is recognizable we would therefore say that typical *fasciatus* shows convergence toward it in southern Illinois and that in the extreme southern portion of the state occasional individuals of *fasciatus socius* appear in series which are predominantly intermediate.

N. fasciatus tinnulus Fulton.—Discontinuous in its distribution and found only in woodland undergrowth, *fasciatus tinnulus* is known from all but the northern portion of Illinois, as far north as Amboy, Hilliary and Muncie.

The coloration of less than half of the specimens listed is normal, the others being considerably darker and consequently less easily distinguishable from typical *fasciatus*. In a large series from Urbana five are so referred, the others assigned to *fasciatus fasciatus* though with some uncertainty.

A series of 140 individuals is referred to this sylvan race, the females showing an average longer ovipositor than those from the east as noted by Fulton (1931) for his material from Ames, Iowa.

They are from **Amboy**, **Hilliary** (in woods), **Muncie** (in woods), **Homer**, **Urbana**, **White Heath**, **Charleston** (in woods), **Tower Hill**, **Alton**.

N. maculatus Blatchley.—Deep Lake is a northern limit and the material from there is very small. This sylvan species probably occurs in the undergrowth of forests throughout Illinois.

Deep Lake: Aug. 8, 1906, 11♂, 14♀. **La Grange:** Sept. 11, 1907, 1♀.

Hilliary: Oct. 6, 1906, 1♂, 10♀, in woods. **Muncie:** Sept. 22 to Oct. 13, 1906 and 1907, 10♂, 17♀, in woods. **Homer:** Aug. 29 and Sept. 2, 1905 and 1906, 4♂, 5♀, 3 large juv. **St. Joseph:** Sept. 27, 1904, 4♀, Hart and Chapman. **Urbana:** Oct. 14, 1906, 1♀; Oct. 21, 1907, 1♀. **Tower Hill:** 1931, 1♂, Hunter. **Grafton:** Sept. 8, 1932, 1♂, Ross and Mohr.

N. griseus griseus Walker.—These localities on the shore of Lake Michigan and Lone Rock, Wis. (a female before us), constitute known

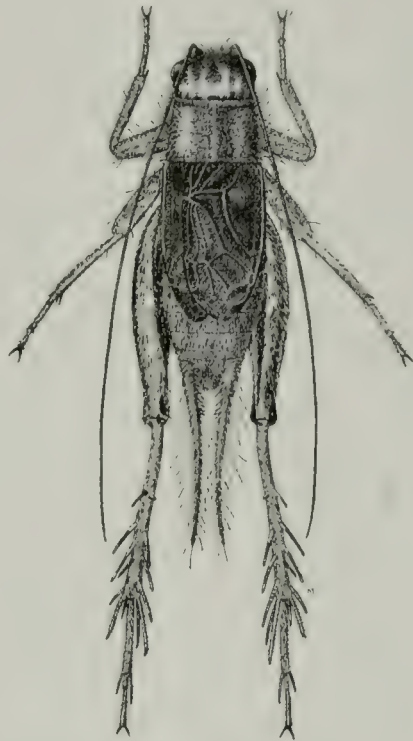


Fig. 116.—Adult male of a small field cricket, *Nemobius fasciatus fasciatus* (DeGeer). $\times 3.4$.

southern limits, so that this race may be looked for locally in sand areas in northern Illinois.

Zion: Aug. 23, 1932, 1 ♂, Ross and Mohr. **Beach:** Aug. 22 and 24, 1906, 14 ♂, 19 ♀, 4 juv., among sand ridges. **Waukegan:** Aug. 18, 1906, 2 large juv. ♀ in swamp area.

N. griseus funeralis Hart.—This record constitutes a northwestern limit and intergradation with *griseus griseus* should be looked for in central Illinois. The present race, though very rarely secured, from the few published records is seen to have a very extensive distribution. It was described from College Station, Tex., and has since been reported from Winslow, Ark. and Macon, Ga. It has been found locally abundant by B. B. Fulton at Raleigh, N. C., and a large series from there has very kindly been secured for us.

Golconda: Oct. 13, 1932, 1 ♂, Frison and Ross.

N. bruneri Hebard.—Hilliary and Muncie are northern limits and the former an eastern limit as well for this species. Material from Springfield, S. D. in the author's collection shows a northwestern limit to be that locality.

The individuals from Pike and Herod, Ill. and a large immature male from Wickliffe, Ky. are unusually large for the species, but the largest specimens of the Muncie series, which shows considerable variation, are of an equal size.

Hilliary: Oct. 6, 1906, 8 ♂, 7 ♀, in woods. **Muncie:** Sept. 22 to Oct. 18, 1906 and 1907, 9 ♂, 12 ♀, in woods. **Homer:** Oct. 7, 1906, 1 ♂, 1 ♀. **Pike:** May 26, 1906, 1 large juv. ♂. **Grand Tower:** June 1, 1906, 1 ♂; June 27, 1913, 1 ♂ at light. **Herod:** Aug. 9, 1905, 1 ♂, macropterous; Sept. 7, 1933, 2 ♂, 1 ♀, Ross and Mohr.

N. cubensis palustris Blatchley.—Careful analysis of very large series now available gives convincing evidence that *palustris* cannot be considered more than an ecological race of *cubensis*.

It is true that in the northeastern United States the present subspecies alone occurs, but we have very similar specimens from the mangrove swamps near Miami, Fla. Typical *cubensis* is distinguished, as we noted in 1913, mainly by its greater size and paler color.

Beach and Long Lake are northern limits. Though as yet known only from extreme northeastern Illinois, the insect should be found locally in swamps throughout the state. A northwestern limit is Springfield, S. D. as shown by specimens in the author's collection.

Most of the following specimens are very small and very dark, but a few are distinctly larger than the others and several are distinctly paler.

Beach: Aug. 21, 1906, 1 ♂ in swamp. **Waukegan:** Aug. 20, 1906,

1♀ in swamp. **Chicago:** Sept. 23, 1904, 1♀ in 79th street meadow, Hancock.

Long Lake: Aug. 11, 1906, 10♂, 9♀, 2 juv., in tamarack bog.

N. carolinus carolinus Scudder.—One hundred and forty-seven specimens, of which 20 are macropterous, are from all portions of Illinois. Decided individual variation in size and depth of coloration is shown by the series.

N. confusus Blatchley.—Muncie and Tower Hill constitute northern limits and Tower Hill is also a western limit for this secretive species which lives in the ground litter in dark woodlands.

This species is rare in collections and upon our request for aid, Mr. L. Hunter has very kindly secured for us this fine series. He writes:

During July the nymphs are rather numerous in the damp half filled washes of the esker upon which I live. Upon maturing, the females seem to be more numerous. Toward the end of September few are to be found in these ditches. They have scattered to the tops of the wooded slopes and there the males, which have become more numerous, may be heard calling—a rather unusual “Cha-w-e-e-d, Cha-w-e-e-d, Cha-w-e-e-d,” the “Cha” dim and unaccented, but the “w-e-e-d” trilled and louder.

Muncie: Oct. 18, 1907, 1♀. **Tower Hill:** 1931, 3♂, Hunter; Aug. 21, 1932, 4♂, 10♀, Hunter; late Sept. 1932, 17♂, 6♀, Hunter. **Metropolis:** Sept. 4, 1932, 1♂, Ross and Horsfall.

OEACANTHINAE

Oecanthus Serville

KEY TO SPECIES

1. Antennae with black marks on the two proximal segments, these markings obsolete only in specimens of *nigricornis quadripunctatus* showing extreme recession. Front of head and bases of antennae never pinkish. Dorsal surface of male tegmina less than half as broad as long. 2
- Antennae lacking black marks on proximal joints, which with adjacent portions of the head are usually suffused with pinkish, fig. 162, 6, p. 252. Dorsal surface of male tegmina more than half as broad as long. Coloration in life whitish faintly tinted with green. Prefers low oaks. . . *latipennis*, p. 254
2. First two antennal segments each with a single small black mark, fig. 162, 4 and 5. Occiput often weakly suffused with orange-brown. 3
- First two antennal segments each with two black marks, sometimes coalesced into irregular patches, fig. 162, 1 and 2. 5
3. First antennal segment with a longitudinal black mark. Male tegmina narrower. 4
- First and second antennal segments each with a black dot or mark, fig. 162, 4. Male tegmina broader. Bush, vine and tree inhabitant. . . *niveus*, p. 253
4. First antennal segment with a longitudinal black mark, second with a black dot. Size averaging appreciably larger. More definitely arboreal.
- *exclamationis*, p. 252

OECANTHUS—KEY TO SPECIES—CONT'D

First antennal segment with a J shaped black mark, second with a black dot, fig. 162, 5. Size averaging appreciably smaller. Bush, vine and tree inhabitant.....*angustipennis*, p. 253

5. Marks on first antennal segment normally not as heavy, separated by an interval at least as wide as the widest of them, varying individually through mere lines to obsolete, in rare cases of maximum recession. Form less robust. General coloration pale, never with striking markings. Prefers pithy stemmed herbs.....*nigricornis quadripunctatus*, p. 253

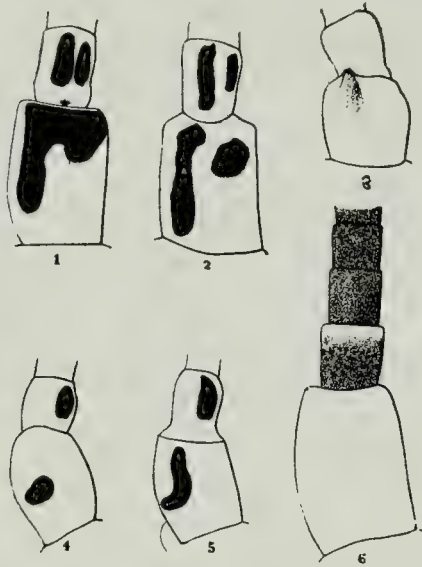


Fig. 162.—Basal segments of antennae of *Oecanthus* and *Neoxabea* spp. 1, *Oecanthus nigricornis*. 2, *Oecanthus nigricornis*. 3, *Neoxabea bipunctata*. 4, *Oecanthus niveus*. 5, *Oecanthus angustipennis*. 6, *Oecanthus latipennis*. (After Hart, Entomological News, vol. III, p. 33.)

Marks on first antennal segment heavier, often confluent, varying individually to separated by an interval in extreme cases as wide as the widest mark, fig. 162, 1, 2...6

6. Form less robust. General coloration pale, never with striking markings. Prefers pithy stemmed herbs.....

.....*nigricornis argentinus*, p. 253

Form averaging slightly more robust. General coloration pale, in intensive material with proximal antennal joint suffused, other portions of antennae, head, ventral surface of abdomen, legs (except caudal femora) and three longitudinal bands on pronotum black, the latter sometimes fused. Prefers large coarse herbaceous plants.....

.....*nigricornis nigricornis*, p. 253¹²

O. exclamationis Davis.—This insect occurs over southern and middle Illinois as far north as St. Joseph, Decatur and Grafton, the westernmost points for it being central Missouri—Willard (material before us) and Hollister.

Though it is the scarcest species of the genus in the United States, we are satisfied that its rarity in collections is partially due to the fact that it is more strictly arboreal than the others. In the fall individuals creep down the trunks of trees, and in such environment we secured a moderate series on September 13, 1903, at Chestnut Hill, Pa.

St. Joseph: July 29, 1919, 1♂. **Urbana:** Aug. 10 and 11, 1932, 2♂, 1♀, on *Quercus macrocarpa*, Knight; Sept. 9, 1898 and Oct. 15, 1907, 2♀ in woods. **Decatur:** Oct. 11, 1907, 1♀. **Grafton:** Aug. 26, 1905, 1♀. **Clay City:** Aug. 22, 1905, 1♂. **Dubois:** Aug. 23, 1905, 1♀. **Aldridge:** Aug. 12, 1891, 1♀, Hart and Shiga.

¹²We are not yet satisfied that we can separate correctly individuals of this race showing extreme recession in coloration from those of *nigricornis quadripunctatus*, though intensive material is so very different in appearance.

O. angustipennis Fitch.—McNeill recorded *angustipennis* from Moline in 1891.

Though the species averages smaller, individuals are occasionally quite as large as the normal for *exclamationis* Davis.

The range of this common tree cricket undoubtedly covers all of Illinois, Algonquin being a northern limit in this latitude.

One hundred and eight specimens, taken August 14 to October 16, are from Algonquin, Havana, Danville, Muncie, Urbana, Decatur, Shawneetown, Carbondale, Boskydell, Golconda, Dixon Springs, Karnak, Cache.

O. niveus (DeGeer).—This is a common species which includes all of Illinois in its range. In this latitude Fond du Lac, Wis. (male in author's collection) is a northern limit.

Twenty-six specimens taken August 2 to October 16 are from Zion, Lake Forest, Cedar Lake, Woodstock, Algonquin, Riverside, Willow Springs, Normal, Havana, Urbana, Monticello, St. Francisville, Centralia.

O. nigricornis quadripunctatus Beutenmüller.—Recording this species from Illinois as *fasciatus* (based on a misidentification by Fitch), McNeill in 1891 did not distinguish between the races.

This insect is found throughout Illinois, but in the southern portion is far less abundant than the western race *nigricornis argentinus*.

Seventeen specimens typical of this insect were taken June 28 to September 14 at Chicago, Sun Lake, Wauconda, Algonquin, Moline, St. Anne, Havana, Urbana, Arenzville, Charleston, Grafton, Alton, Clay City, Shawneetown, Harrisburg, Carbondale, Williams Mountain, Alto Pass, Anna, Metropolis, Pulaski, Cache.

O. nigricornis argentinus Saussure.—Urbana and Bishop constitute northern, and St. Francisville and Mt. Carmel the eastern limits of this western race, which occurs throughout the southern and central portions of Illinois.

One hundred and one specimens, taken June 27 to September 20, are from Bishop (four class 8¹³), Topeka (one class 8), Havana (four class 8), Urbana (one class 7), Quincy (six class 8), Casey, Hillsboro, Alton, Lawrenceville, St. Francisville (two class 8), Centralia (one each class 5, 6), Mt. Carmel (one class 7, seven class 8), Albion (two class 8), Grayville, Dubois (one class 6, four class 7, 17 class 8), Shawneetown, Harrisburg (11 class 8), Carbondale (two class 7, 15 class 8), Murphysboro (three class 8), Grand Tower (two class 7, 10 class 8), Hicks Branch, Eichorn, Cobden (three class 8), Alto Pass (four class 8), Elizabethtown, Golconda, Vienna, Karnak, Ullin, Pulaski (one class 8), Cache, Cairo (one class 7).

O. nigricornis nigricornis F. Walker.—We have had great difficulty distinguishing pallid recessive eastern material of *nigricornis nigricornis* from *nigricornis quadripunctatus*. Both these races occur

¹³These classes represent the artificial classification of color variation in this species used by Fulton (1926).

throughout Illinois and though the above material is satisfactorily separable, there remain 45 specimens which appear to be intermediate to different degrees. These are from Topeka, Havana, St. Joseph, White Heath, Quincy, Centerville, Grand Tower, Metropolis, Thebes.

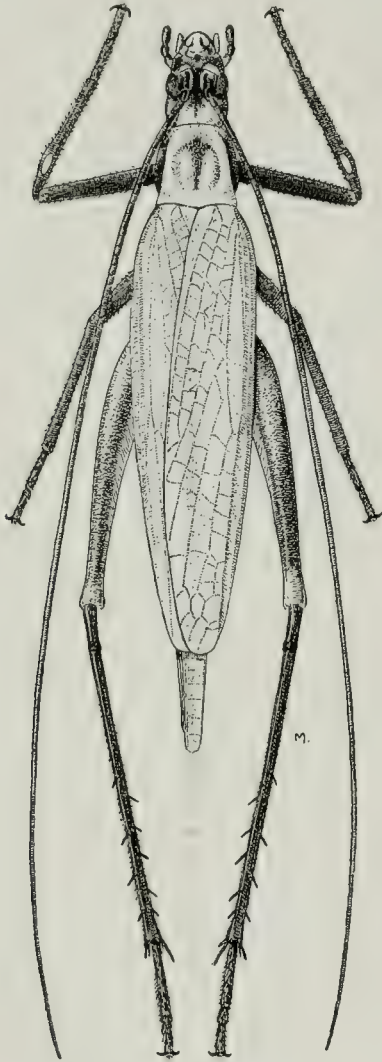


Fig. 163.—Adult female of a tree cricket, *Oceanthus nigricornis nigricornis* F. Walker. $\times 4$.

over all but extreme northern Illinois. Glen Ellyn is the known northern limit.

Glen Ellyn: Sept. 7, 1903, 1♀, Gerhard, *FM*. **LaGrange:** Sept. 11, 1907, 1♂ with coloration strongly recessive. **Riverside:** Sept. 1, 1893, 1♀ strongly intensive, Hancock. **Willow Springs:** Aug. 21, 1910, 1♀, Gerhard, *FM*. **Joliet:** Aug. 31, 1930, 2♀ intensive, Knight and Ross. **Hilliary:** July 29 and Aug. 7, 1909, 2♂ strongly recessive, 1♀ recessive. **Urbana:** July 22, 1893, 1♂ strongly recessive; July 31, 1900, 1♀ moderately intensive. **Manchester:** Aug. 23, 1892, 1♀ intensive, McElfresh. **Mascoutah:** 1890, 1♀ recessive. **Grayville:** June 25, 1932, 1 large juv. ♂, Ross, Dozier and Park.

Eighty-one specimens, taken July 12 to September 29, are from **Zion, Beach** (one with dark markings moderately heavy, others very weak), **Ravinia** (five weak), **Riverview**, **Channel Lake** (one very weak), **Wauconda** (three moderately heavy), **Algonquin**, **Rockford** (one very weak), **Fulton**, **Urbana** (one very heavy, two weak, two very weak), **Seymour** (two heavy), **Borton**, **Charleston** (two heavy), **Alton**, **Lawrenceville**, **Centralia** (one very weak), **Norris City**, **Shawneetown** (13 heavy), **Carbondale** (one moderately heavy), **Grand Tower** (eight very weak), **Elizabethtown**, **Golconda** (one weak), **Dixon Springs**, **Cypress** (one weak).

O. latipennis Riley.—This oak loving species is probably numerous in southern Illinois. Northern limits of distribution are Hilliary and Quincy.

McNeill reported this species from Carmi in 1891.

Thirty-four specimens, taken July 31 to October 13, are from **Hilliary**, **Quincy**, **Borton**, **Grafton**, **Lawrenceville**, **Odin**, **Carmi**, **Boskydell**, **Grand Tower**, **Herod**, **Jonesboro**, **Golconda**, **Metropolis**, **Karnak**, **Dongola**, **Olive Branch**.

Neoxabea Kirby

N. bipunctata (DeGeer).—McNeill reported this species from Rock Island in 1891, referring it to *Oecanthus*.

This scarce species, preferring vine tangles in and along forests, probably occurs

TRIGONIDIINAE

Anaxipha Saussure

A. exigua (Say).—This species was recorded from Colona as *A. pulicaria* by McNeill in 1891.

Muncie, Urbana and Colona are known northern limits. The species should be found only locally abundant in southern Illinois. It probably occurs to the north though in greatly reduced numbers as it has been found on the Mississippi river as far north as extreme southeastern Minnesota.

Eighteen males, seven females, taken July 22 to September 30, and five immatures are from **Havana, Muncie, Urbana, Quincy, Tower Hill, Lawrenceville, St. Francisville, East St. Louis, Carbondale, Vienna, Karnak, Olive Branch.**

Cyrtoxipha Saussure

C. columbiana Caudell.—This is an exceedingly interesting record, extending far northward the known distribution of this arboreal, very delicate light green cricket, in the Mississippi valley. Other western limits are Polk county, Ark. (female in author's collection) and Dallas, Tex.

The insect is probably very scarce in extreme southern Illinois, where it should be sought for by beating the foliage in deciduous forests.

Carbondale: Sept. 26, 1909, 1♀, Gerhard, *FM*.

Phyllopalpus Uhler

P. pulchellus Uhler.—McNeill recorded this insect as a *Phylloscirtus* from Pine Hill in 1891.

Confined to southern and central Illinois, this beautiful and richly colored little cricket is probably moderately abundant locally in weeds growing in wet spots.

Marion county, Ind. and Monticello, Ill. are northern limital points; known western limits are the latter, Grand Tower and Olive Branch.

Monticello: Aug. 17, 1883, 1♂, Seymour. **St. Francisville:** Sept. 8, 1933, 1♂, 1♀, Ross and Mohr. **Carbondale:** Sept. 26, 1909, 4♂, 1♀, Gerhard, *FM*. **Grand Tower:** Aug. 10, 1891, 1♀, Hart and Shiga. **Herod:** Aug. 9, 1905, 1♀. **Metropolis:** Sept. 3, 1924, 1♀, Frison, **Karnak:** Sept. 2, 1924, 1♀, Frison. **Pulaski:** June 2, 1910, 1 very small juv. **Olive Branch:** Sept. 29 to Oct. 3, 1909, 6♂, 5♀, Gerhard, *FM*.

ENEOPTERINAE

Hapithus Uhler

H. agitator agitator Uhler.—Due to incorrect generic association

a female from Illinois was described as *Orocharis uhleri* by McNeill in 1891.

This series averages from large to small with apparently little geographic significance, as both extremes are shown by Dubois females while the entire series from Karnak is very small. One female from the former locality is unusually large with exceptionally well developed tegmina; length of body 13.8 mm., length of tegmen 12 mm., length of caudal femur 11.7 mm., length of ovipositor 12.8 mm.

This rather common though secretive bush loving cricket occurs only in southern and central Illinois. Muncie is the northern limit.

Eighteen males, 43 females, taken August 16 to October 1, and 18 immatures are from **Muncie, Borton, Charleston, Manchester, Tower Hill, Hillsboro, Grafton, Lawrenceville, Clay City, Odin, Centralia, Norris City, Dubois, Equality, Carbondale, Boskydell, Grand Tower, Herod, Cobden, Ware, Elizabethtown, Metropolis, Vienna, Cypress, Karnak, McClure, Thebes.**

Orocharis Uhler

O. saltator Uhler.—This retiring cricket, found in vines and on trees, is as yet known only from extreme southern Illinois, Shawneetown being a northern limit point. It should however be found throughout southern Illinois as it is known as far north as central Indiana. We have recently noted (1932) that Lugger's figure in his Minnesota report (1897) was certainly drawn from material which did not come from Minnesota.

A synonym, indicated by Blatchley in 1903 but not mentioned by him in 1920, is his *Apithes mcneilli*.

Shawneetown: Oct. 12, 1932, 1♂, 2♀, Frison and Ross. **Herod:** Aug. 8, 1898, 1 juv.♂, Hart. **Alto Pass:** Aug. 15, 1909, 1♂. **Union county:** Sept. 10 to 16, 1908, 2♂, 1♀, on apple and forest trees, Smith. **Karnak:** Sept. 8, 1924, 1♂, 1 juv.♀, Frison.

MOGOPLISTINAE

Cycloptilum Scudder

C. squamosum Scudder.—This species was correctly recorded from Metropolis by Blatchley in 1920, but the southeastern insect which was generally referred to *squamosum* is a distinct species, described by us as *C. bidens* in 1931.

Tower Hill: 1931, 4♂, 3♀, Hunter, HC. **Metropolis:** Aug. 18, 1891, 2♂, 1♀, in woods at foot of bluff.

These are northeastern limits for *squamosum*. To the south it is probably found over a very large area, as it is known as far southeast as Cedar Keys, Fla.

MYRMECOPHILINAE

Myrmecophila Latrielle

M. pergandei Bruner.—Though Murphysboro is a northern limit, this inhabitant of ant nests probably occurs throughout southern Illinois, as it is known from Indiana as far north as Mitchell.

Shawneetown: Apr. 23, 1926, 2♂, 1♀, 1♂ rather small, pair small, Frison and Auden. **Murphysboro:** May 16, 1910, 2♂, small, 1♀, very small.

Olive Branch: Sept. 29, 1909, 1♀, 6 juv., Gerhard, *FM*.

GRYLLOTALPINAE

Gryllotalpa Latrielle

KEY TO SPECIES

- Caudal tibiae with four internal and four external spines. Cephalic trochanter with process short, nearly semicircular, armed with spinose hairs. Large.**hexadactyla**, p. 257
- Caudal tibiae with three internal and four external spines. Cephalic trochanter with process knifelike, curved, acute. Very large.**major**, p. 258

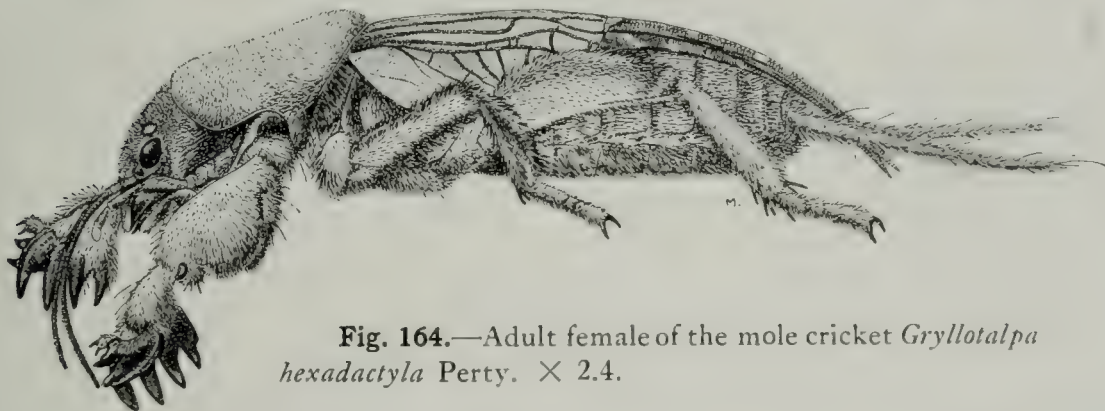


Fig. 164.—Adult female of the mole cricket *Gryllotalpa hexadactyla* Perty. $\times 2.4$.

G. hexadactyla Perty.—McNeill recorded this species in 1891 from Rock Island and Moline as the synonyms *columbia* and *borealis*.

All of the present series are macropterous except six, three having moderately and three strongly reduced tegmina and wings. Scarcity of males in northern series has been previously observed by us and suggests parthenogenesis. The northernmost males before us are one in four specimens from Kansas and one in 11 from Nebraska.

This species certainly occurs over all of Illinois, though it is apparently decidedly more numerous in the central portion of the state than elsewhere. It is not frequently seen as it is not only nocturnal but lives most of the time in its underground burrows.

A northern limital point is shown by a macropterous female from Osceola, Wis. in the author's collection.

Thirty-one females, taken July 18 to September 20, and one immature are from **Fourth Lake, Fox Lake, McCollums Lake, Algonquin, Verona,**

Rock Island, Pekin, Fithian, Urbana, Champaign, White Heath, Clinton, Hume, Kansas, Oakland, Sullivan, Rockport, Carlinville, Albion.

G. major Saussure.—Described in 1874 from "Illinois," no material from this state has been seen by us. The type was however probably correctly labeled, as *major* is known from Carthage, Mo., and a southeastern published limit is Louisville, Miss. Westward the species is not known beyond the eastern limits of the great plains.

TRIDACTYLINAE

Tridactylus Olivier

KEY TO SPECIES

- Caudal metatarsi present. Larger. Pronotum with a weak transverse sulcus. Shining brown, little or not maculate.....**apicalis**
- Caudal metatarsi absent. Smaller. Pronotum not sulcate. Blackish brown, usually strikingly maculate with buffy.....**minutus**



Fig. 165.—Adult male of the pygmy mole cricket *Tridactylus minutus* Scudder. $\times 15$.

T. apicalis Say.—Thomas' *illinoisensis* is an established synonym, described from Illinois in 1863. The species has been reported from southern Illinois and as the established synonym *terminalis* from Urbana and Quincy by McNeill in 1891.

Decided individual size variation occurs in both sexes, females being best distinguished by the slight concavity mesad of the distal margin of the penultimate sternite.

This insect occurs about lakes and watercourses throughout the state. On the Mississippi it is known as far north as southeastern Minnesota.

Seventeen males, 43 females, taken May 8 to September 11, and eight immatures are from Beach, Chicago, Savanna, Peoria, Havana, Urbana, Matanzas Lake, Quincy (on sand bar), Kampsville, Herod, Elizabethtown, Olive Branch.

T. minutus Scudder.—This species was reported from Champaign by McNeill in 1891.

About half the adults of this series are macropterous, the others brachypterous.

We have recently found the characters which were used to separate *Ellipes* insufficient to distinguish it from *Tridactylus*. Unlike *apicalis*, the females in *minutus* average slightly larger than the males, and in them the penultimate sternite has its sides convergent to the rounded apex, leaving the cleft ultimate tergite partially exposed.

This minute insect occurs throughout Illinois like the preceding species, but is much more abundant and more generally distributed in similar environments. It also is known on the Mississippi north to southeastern Minnesota.

Fifty males, 53 females, taken April 17 to September 10, and 16 immatures are from Waukegan, Willow Springs, Flossmoor, Bradford, Danvers, Havana, Muncie, Oakwood, Urbana, Champaign, White Heath, Quincy, Robinson, Mt. Carmel, Browns, Norris City, Dubois, Shawneetown, Carbondale, Makanda, Grand Tower, Herod, Hicks Branch, Eichorn, Parker, Anna, Jonesboro, Elizabethtown, Golconda, Metropolis, Dongola, Pulaski, Villa Ridge, Olive Branch, Thebes.

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APPENDIX

GRASSHOPPER CONTROL

GRASSHOPPERS are among the most general plant feeders of the many kinds of insects occurring in Illinois. Their food includes practically all the garden crops and flowering plants, nearly all the ornamentals, the foliage and bark of many trees, especially while the trees are young, and all the wild as well as cultivated grasses. Grasshoppers have caused damage in the state from the time the first settlers made their clearings and planted their first crops. There is every year some damage from these insects to field crops, gardens and particularly ornamentals, but up to the present Illinois has not suffered to nearly the same extent as states west of the Mississippi river. Serious grasshopper losses occur at irregular periods in local areas with no definite time of reoccurrence of injury as is the case with some insects.

Of the many species of grasshoppers that occur in Illinois only three are of much importance economically. These are (1) the red legged grasshopper, *Melanoplus femur-rubrum*, a medium sized brownish red grasshopper about an inch long, (2) the lesser migratory grasshopper, *Melanoplus mexicanus*, which is about the same size as the red legged grasshopper, and (3) the differential grasshopper, *Melanoplus differentialis*, which is 1½ inches or more in length when full grown.

Natural Control

Grasshopper populations are affected to a marked degree by weather and usually become most abundant after a period of dry years. There are a number of insect, bird and animal enemies of grasshoppers which play an important part in holding down their numbers. Some of the most important of these are certain flies (Bombyliidae) and blister beetles (Meloidae) whose larvae feed upon the grasshopper egg masses. A heavy toll is made on grasshopper populations by fungus diseases, mites, tachinid flies, many species of birds, snakes and small mammals.

Applied Control

There are three standard methods of grasshopper control which may be used in years when the insects are abundant. In order of importance, these are the use of poisoned bait, trapping and cultivation.

POISON BAITS.—In the western areas poison bait is now depended upon almost entirely for grasshopper control. Grasshoppers are attracted to certain odors and it has been found comparatively easy to poison very large numbers of them. Hundreds of tons of poisoned bait have been used in the western states during the past few years, in

many cases the bait being made up literally by the trainload and distributed over the heavily infested areas.

Preparation.—About the most satisfactory bait and the one which is now generally recommended contains sodium fluosilicate, white arsenic or Paris green as the poisoning agent, and is made up as follows:

Coarse wheat bran free from shorts.....	100 pounds
Sodium fluosilicate, white arsenic or Paris green.....	5 pounds
Molasses, preferably black strap.....	2 gallons
Water, sufficient to make a stiff mash, usually 10 to 12 gallons.	



Fig. 166.—Corn and sweet clover destroyed by grasshoppers. (After Drake and Decker, Iowa Extension Service Bulletin 182)

The bran and poison are thoroughly mixed together while dry. The water and molasses are then mixed and added to the grain. This can be done on a concrete or other floor, using scoop shovels in the same manner as mixing cement. Very thorough mixing is necessary and the bran must be shoveled over until all the lumps have been worked out. Where considerable amounts of bait are needed a cement mixer can be conveniently used for mixing the bait. There are a number of commercial companies that make this bait. It is usually sold with bran, poison and sweetening mixed. The water is added to it just before the bait is used.

Small amounts of the bait can be made, using the following formula.

Bran.....	5 pounds
Molasses.....	$\frac{3}{4}$ pint
Water.....	2 quarts
Paris green or sodium fluosilicate.....	$3\frac{1}{2}$ ounces

Thoroughly mix the bran and poison while dry. Then mix the molasses with the water and slowly add to the bran, stirring constantly.

It is important to get an even distribution of the poison and molasses in the bait.

Application.—The bait should be applied early in the morning at the rate of 20–25 pounds of wet mash for each acre of ground, distributed as evenly and thinly as possible over the entire surface. It is far more effective when put out in this way than when distributed in windrows, lumps or small piles. Where the bait is used around home gardens or ornamental plantings, small truck patches or small fields, it can be readily applied by hand, carrying the bait in a basket or bucket.

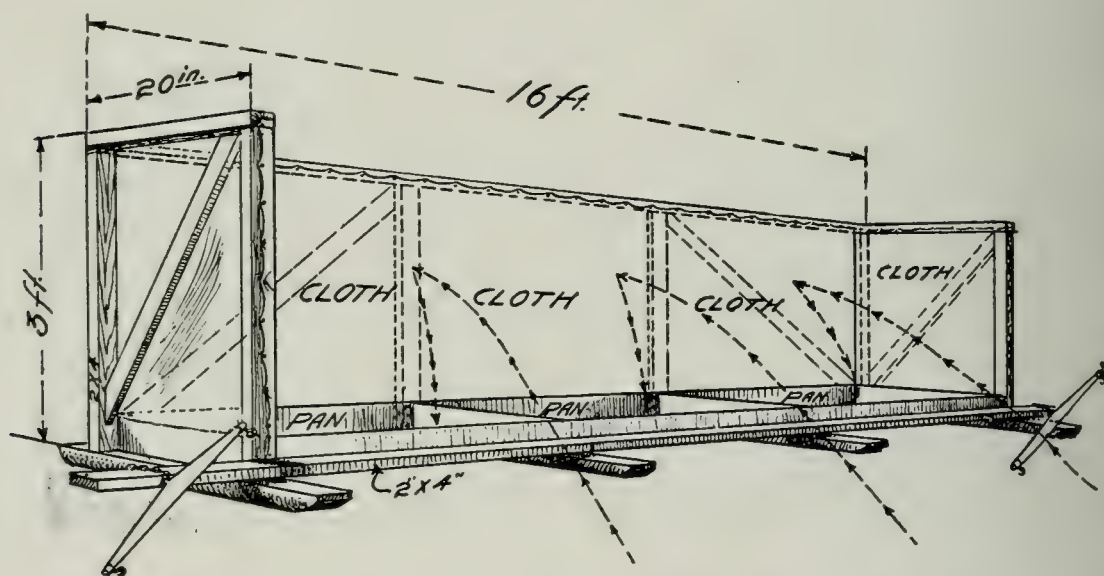


Fig. 167.—Hopperdozer with cloth back showing construction. (After Walton, Farmers' Bull. 747, U. S. Dept. Agr.)

For larger areas it can be sown by hand from the rear of wagons or may be distributed by an end-gate oat seeder, regulating the seeder to put out the right amount of poison. In the wholesale poisoning work carried on in the west, airplanes have been used for distributing the bait over large waste areas. The poison works rather slowly and dead grasshoppers will not be found before the second or third day after the bait has been applied. As the pests become sick from the poison they tend to crawl away and hide and one has to look rather carefully in order to find them.

Kill.—It has been repeatedly demonstrated that a thorough application of the above poison over an infested area will kill 60–80 per cent of all grasshoppers there.

TRAPPING.—Results of the last few years' work with hopperdozers and hoppercatchers have shown that poisoning is usually far cheaper and more effective than trapping. A hopperdozer, fig. 167, however can be readily made by following these specifications:

The hopperdozer is made with a shallow trough or pan 20 inches wide, with 6-inch sides, set on the 2x4 runners directly in front of the shield. This pan should have partitions across it every 3 or 4 feet. To operate the hopperdozer, partly fill the pan with water, pour a little kerosene on top and drag across the infested fields. The hoppers striking the shield fall into the pan where they are quickly killed by the oil. Once having become wet with the kerosene they will die in a few minutes even though they hop out of the pan.

The hopperdozer is somewhat easier and less expensive to build than the catcher, and is about as effective. A catch of 60 bushels of grasshoppers on 20 acres of clover was recently made with one of these machines.¹⁴

CULTIVATION.—Control of grasshoppers by cultivation is designed to destroy the eggs in fall and winter. It consists of fall plowing or disking areas in which the grasshoppers have laid their eggs, thus exposing them to birds and the weather. Cultivation to a depth of 4 inches is usually sufficient for this purpose.

COCKROACH CONTROL

COCKROACHES are one of the most annoying pests encountered in dwellings, restaurants and like places. Their food consists of many things, including bindings of books or magazines and practically all foodstuffs, especially of a starchy nature. They leave a slight but disagreeable odor wherever they frequent. In warm, dark places, such as around enclosed stoves in restaurants and bakeries, these insects sometimes multiply in enormous numbers and from this haven overrun the whole establishment.

The most effective control for these pests is dusting with sodium fluoride (not sodium chloride, which is common salt). This dust should be sprinkled liberally in dark corners, behind stoves, cabinets, etc., and in cracks in the wall. Persistent treatment of this kind, if thoroughly applied, will clean up an infestation.

Cockroaches spread from one house to another, so that it is entirely possible to have recurring infestations of these insects, which will necessitate almost continuous control measures.

¹⁴Grasshopper control in relation to cereal and forage crops, W. R. Walton, U. S. D. A. Farmers' Bull. 747, October, 1916.

INDEX TO SUBFAMILIES, GENERA AND SPECIES

Page numbers in this index are for occurrence of the names in the catalog of species, pp. 150-259, only. Numbers in light face type refer to mere mention of the name or its location without discussion; numbers in bold face show location of discussions or keys in the case of families and genera, and discussions or collection records for species. Placement of names in keys is not indexed.

A

- abbreviatus, Gryllus 246
 abdomen-nigrum, Epilampra **158**
 acadicum acadicum, Acridium 167, **169**
 Acrididae **162**
 Acridinae 173
 Acridium **168**
 acadicum acadicum 167, **169**
 arenosum arenosum 169-70
 angustum **169**
 granulatum **168**
 ornatum **169**
 triangularis 169
 Acrydiinae 166
 aculeata, Forficula 151
 aculeatum aculeatum, Doru **151**
 acuminatus, Nomotettix 166
 acuta, Tettigidea **172**
 acutipennis, Campylacantha 189
 admirabilis, Syrbula **174**
 aequalis, Oedipoda 186
 Ageneotettix 178
 deorum **178**
 scudderi 178
 agile, Orchelimum 213
 agitator agitator, Hapithus **255**
 alutacea, Schistocerca **189**
 Amblycorypha **206**
 oblongifolia **206**
 rotundifolia rotundifolia **207**
 uhleri **206**
 americana, Periplaneta **157**, 158
 americana americana, Schistocerca **188**
 americanus, Atlanticus 219
 hesperus **219**
 Amphitornus 175
 bicolor 175
 coloradus **175**
 Anaulacomera 206
 Anaxipha 255
 exigua **255**
 pulicaria 255
 angustipennis, Melanoplus **198**
 angustipennis, Oecanthus **253**
 angustum, Acridium arenosum **169**
 Anisomorpha 159
 ferruginea **159**
 buprestoides 160
 Anisomorphinae 159
 Anurogryllus 247
 muticus **247**
 apicalis, Diestrammena **220**
 apicalis, Tridactylus 258, **259**
 apiculata, Pardalophora **182**, 183
 apiculata, Tettigidea 172
 Apithes mceilli 256
 arboreus, Melanoplus punctulatus 196
 arcuata, Marsa 243
 arcuatus, Nomotettix cristatus 168
 argentinus, Oecanthus nigricornis **253**
 arenosum angustum, Acridium **169**
 arenosum 169-70
 armata, Machamala 227
 armata, Tettigidea 172
 depressa 172
 Arphia **179**
 carinata 180
 pseudonietana **180**
 sulphurea **179**
 xanthoptera **180**
 assimilis, Gryllus **246**
 luctuosus 246
 neglectus 246
 scudderianus 246
 asynamorus, Tachycines 220, **221**
 ater, Ceuthophilus 243
 atlanis, Melanoplus 197
 atlantica atlantica, Paroxya **200**
 atlantica, Diapheromera blatchleyi 160
 atlantica, Diapheromera persimilis 160
 Atlanticus **218**
 americanus 219
 hesperus **219**
 davisii **219**

pachymerus 219
 testaceus 219
 attenuatus, Conocephalus 217
 australasiae, Periplaneta 156, 157
 autumnalis, Pezotettix 199

B

belfragii, Oedipoda 184
 bicolor, Amphitornus 175
 bicolor, Ceuthophilus 226
 bidens, Cycloptilum 256
 bipunctata, Neoxabea 254
 bivittata, Mermiria 174
 bivittatus, Melanoplus 195
 blatchleyi, Ceuthophilus 227
 blatchleyi, Diapheromera 160, 162
 atlantica 160
 blatchleyi 160
 blatchleyi, Melanoplus 194
 Blatta 157
 orientalis 157
 Blattella 153
 germanica 153
 Blattidae 152, 157
 Blattinae 156, 158
 bolli, Spharagemon 184
 bolliana, Parcoblatta 154
 bolteri, Neotettix 170
 borealis, Gryllotalpa 257
 borealis, Nomotettix 166
 borealis borealis, Melanoplus 197
 junius 197
 brachyptera, Pseudopomala 173
 bradleyi, Orchelimum 215
 brevicornis, Truxalis 173
 brevipennis, Conocephalus 216
 brevipes, Ceuthophilus 227, 229, 232,
 234, 235, 236
 bruneri, Nemobius 250
 bruneri, Neoconocephalus 211
 bullatum, Orchelimum 214
 buprestoides, Anisomorpha 160

C

caecus, Ceuthophilus 237
 calcaratum, Orchelimum 213
 Caloptenus occidentalis 194
 camellifolia, Pterophylla 208
 Camnula 181
 pellucida 181
 campestre, Orchelimum 214

campestre, Orchelimum concinnum 214
 Camptonotus 220
 carolinensis 220
 Campylacantha 189
 acutipennis 189
 olivacea olivacea 189
 canus, Nemobius 248
 carinata, Arphia 180
 carolina, Dissosteira 184
 carolina, Stagmomantis 158
 carolinensis, Camptonotus 220
 carolinus carolinus, Nemobius 251
 cenchri, Melanoplus 199
 Ceuthophilus 222
 ater 243
 bicolor 226
 blatchleyi 227
 brevipes 227, 229, 232, 234, 235, 236
 caecus 237
 devius 243
 divergens 227, 236, 237
 elegans 237
 fusiformis 237, 240, 241, 242
 gracilipes 227, 228, 229, 235, 236
 lapidicola 227
 latebricola 226, 227
 latens 227, 228
 maculatus 226, 236
 meridionalis 228
 niger 243
 nigricans 227
 nodulosus 227
 occultus 237, 239, 242
 pallidipes 227
 politus 243
 scriptus 227
 seclusus 226, 227, 236
 silvestris 237, 239, 242
 stygius 229
 tenebrarum 227
 terrestris 226, 227, 229, 230
 uhleri 236
 uniformis 227
 williamsoni 230
 Chloealtis 177
 conspersa 177
 Chorthippus 177
 curtipennis 177
 Chortophaga 180
 viridifasciata 180
 Circotettix verrucullatus 186

- citrina*, *Trimerotropis* 186
clavuliger, *Paroxya* 200
collare, *Spharagemon* 184
coloradus, *Amphitornus* 175
columbia, *Gryllotalpa* 257
columbiana, *Cyrtoxipha* 255
collinus, *Melanoplus* 198
compacta, *Udeopsylla* 243
compressus, *Nomotettix* 167
compressus, *Nomotettix cristatus* 167, 168
concavus, *Cyrtophyllus* 208
concinnum, *Orchelimum* 214
 campestre 214
 concinnum 214
 delicatum 214, 215
confusus, *Melanoplus* 196
confusus, *Nemobius* 251
Conocephalinae 211
Conocephalus 215
 attenuatus 217
 brevipennis 216
 ensifer 216
 fasciatus fasciatus 216
 nemoralis 216
 nigropleurum 217
 saltans 218
 strictus 217
conspera, *Chloealtis* 177
Copiphorinae 208
corallipes, *Hippiscus* 181
 rugosus 181
crepitans, *Neoconocephalus robustus* 209, 210
cristatus, *Nomotettix* 166
 arcuatus 168
 compressus 167, 168
 denticulatus 167, 168
 cristatus 166, 168
 sinuifrons 167
cubensis, *Nemobius* 250
 palustris, *Nemobius* 250
cubensis, *Panchloria* 158
cucullatus, *Paratettix* 170
curtipennis, *Chorthippus* 177
curvicauda, *Scudderia* 205
 curvicauda 204
Cycloptilum 256
 bidens 256
 squamosum 256
Cyrtacanthacrinae 187
Cyrtophyllus concavus 208
Cyrtoxipha 255
 columbiana 255
- D**
- Daihinia gigantea* 243
 robustus 242
damnifica damnifica, *Schistocerca* 188
davisi, *Atlanticus* 219
davisi, *Tettigidea* 172
dawsoni, *Melanoplus* 196
Decticinae 218
Decticus derogatus 219
delicatum, *Orchelimum concinnum* 214, 215
Dendrotettix 199
 quercus 199
denticulatus, *Nomotettix cristatus* 167, 168
deorum, *Ageneotettix* 178
depressa, *Tettigidea armata* 172
derogatus, *Decticus* 219
deropeltiformis, *Ischnoptera* 153
desertae, *Parcoblatta* 155
detersa, *Neoblatella* 157
devius, *Ceuthophilus* 243
Diapheromera 160
 blatchleyi 160, 162
 atlantica 160
 blatchleyi 160
 femorata 161
 persimilis 160, 161
 atlantica 160
 sayi 161
 velii 162
 velii 162
Dichromorpha 176
 viridis 176
Diestrammena 220
 apicalis 220
 japanica 221
 marmorata 221, 222
 minuta 221
 unicolor 220, 222
differentialis, *Melanoplus* 195, 199
Diplophyllus 206
discoideus, *Pardalophora* 183
Dissosteira 184
 carolina 184
divergens, *Ceuthophilus* 227, 236, 237
domesticus, *Gryllus* 246

Doru 151

- aculeatum aculeatum 151
- lineare 151

E

- elegans, Ceuthophilus 237
- Ellipes 259
- Encoptolophus 181
 - sordidus sordidus 181
- Eneopterinae 255
- ensifer, Conocephalus 216
- ensiger, Neoconocephalus 210
- Epilampra abdomen-nigrum 158
- Epilamprinae 158
- Eritettix 175
 - simplex 175
 - tricaratus 175
 - virgatus 175
- eurycerus, Melanoplus viridipes 192
- Eurycotis floridana 158
- exclamationis, Oecanthus 252, 253
- exigua, Anaxipha 255
- exiliscanorus, Neoconocephalus 211
- extremus, Melanoplus 197

F

- fasciatus, Melanoplus 197
- fasciatus, Nemobius 248, 249
- fasciatus, Oecanthus 253
- fasciatus fasciatus, Conocephalus 216
- fasciatus fasciatus, Nemobius 248
 - socius 248
 - tinnulus 249
- femorata, Diapheromera 161
- femoratus, Neotettix 170
- femur-rubrum, Melanoplus 197
 - femur-rubrum 197
- fenestralis fenestralis, Psinidia 185
- ferruginea, Anisomorpha 159
- flavidus flavidus, Melanoplus 199
- floridana, Eurycotis 158
- fluviatilis, Melanoplus foedus 198
- foedus, Melanoplus 198
 - fluviatilis 198
- Forficula aculeata 151
- Forficulidae 151
- fuliginosa, Periplaneta 156, 157
- fulvens, Ischnoptera uhleriana 155
- fulvens, Parcoblatta 155
- funeralis, Nemobius griseus 250

furcata furcata, Scudderia 205*fuscata*, Scudderia 205*fuscifrons*, Trachyrhachis kiowa 185*fuscifrons texana*, Psinidia 185*fusiformis*, Ceuthophilus 237, 240, 241, 242**G***germanica*, Blattella 153*gladiator*, Orchelimum 213*gigantea*, Daihinia 243*glaberrimum*, Orchelimum 212*gracile*, Stethophyma 178*gracilipes*, Ceuthophilus 227, 228, 229, 235, 236*gracilipes*, Phalangopsis 229*gracilis*, Melanoplus 192*granulatum*, Acridium 168*griseus funeralis*, Nemobius 250*griseus* 249, 250

Gryllacrinae 220

Gryllidae 243

Gryllinae 246

Gryllotalpa 257

borealis 257*columbia* 257*hexadactyla* 257*major* 258

Gryllotalpinae 257

Gryllus 246

abbreviatus 246*assimilis* 246*luctuosus* 246*neglectus* 246*scudderianus* 246*domesticus* 246*luctuosus* 246*pennsylvanicus* 246*vernalis* 246**H**

Hadenoeus 222

puteanus 222*haldemanii*, Pardalophora 183

Hapithus 255

agitator agitator 255

Hesperotettix 189

pratensis 189*speciosus* 190*viridis pratensis* 189

hesperus, *Atlanticus americanus* 219
Heteronemiinae 160
hexadactyla, *Gryllotalpa* 257
Hippiscus 181
 corallipes 181
 rugosus 181
 neglectus 183
 phoenicopterus 182
 rugosus 181
 suturalis 181
 tuberculatus 182, 183
 variegatus 181
holosericea, *Nyctibora* 158
hoosieri, *Paroxya* 200

I

illinoisensis, *Tridactylus* 258
impudicus, *Melanoplus* 196
inhabilis, *Phrixocnemis* 242
Inscudderia 205
 taxodii 205
interior, *Trimerotropis maritima* 186,
 187
Ischnoptera 153
 deropeltiformis 153
 uhleriana fulvescens 155

J

japanica, *Diestrammena* 221
junius, *Melanoplus borealis* 197

K

keeleri luridus, *Melanoplus* 198
kiowa fuscifrons, *Trachyrhachis* 185
 kiowa 184
 thomasi 184

L

Labia 151
 minor 151
Labiidae 151
laevicauda, *Symmetropleura* 205, 206
lapidicola, *Ceuthophilus* 227
lata, *Parcoblatta* 155
latebricola, *Ceuthophilus* 226, 227
latens, *Ceuthophilus* 227, 228
lateralis, *Tettigidea* 171
 lateralis 171
 parvipennis 171

latipennis, *Oecanthus* 254
laurifolium, *Microcentrum* 207
Leptysma 187
 marginicollis 187
lineare, *Doru* 151
lineatum, *Stethophyma* 178
Locusta marmorata 222
longipenne, *Orchelimum* 212
luctuosus, *Gryllus* 246
luctuosus, *Gryllus assimilis* 246
luridus, *Melanoplus keeleri* 198
lyristes, *Neoconocephalus* 210, 211

M

macclungi, *Mermiria maculipennis* 174
Machamala armata 227
macneilli, *Melanoplus* 198
maculata, *Rhaphidorophora* 226
maculatus, *Ceuthophilus* 226, 236
maculatus, *Nemobius* 249
maculipennis, *Orphulella* 176
maculipennis macclungi, *Mermiria* 174
major, *Gryllotalpa* 258
manca, *Pezotettix* 193
Mantidae 158
Mantinae 158
Mantis 159
 religiosa 159
marginicollis, *Leptysma* 187
maritima, *Trimerotropis* 187
 interior 186, 187
marmorata, *Diestrammena* 221, 222
marmorata, *Locusta* 222
Marsa arcuata 243
mcneilli, *Apithes* 256
Melanoplus 190
 angustipennis 198
 atlanis 197
 bivittatus 195
 blatchleyi 194
 borealis borealis 197
 junius 197
 cenchri 199
 collinus 198
 confusus 196
 dawsoni 196
 differentialis 195, 199
 extremus 197
 fasciatus 197
 femur-rubrum 197
 femur-rubrum 197

flavidus flavidus 199
foedus 198
 fluvialis 198
gracilis 192
impudicus 196
keeleri luridus 198
macneilli 198
mexicanus 197
 mexicanus 197
minor 196
morsei 193
obovatifennis 193, 194
ponderosus 194
 ponderosus 195
 viola 194
punctulatus arboreus 196
 punctulatus 196
scudderi scudderi 194
spretis 197
spretus 197
tepidus 194
tunicae 195
viola 195
viridipes 192
 eurycercus 192
 viridipes 192
 walshii 194
meridionalis, *Ceuthophilus* 228
Mermiria 174
 bivittata 174
 maculipennis macclungi 174
 neomexicana 174
mexicanus, *Melanoplus* 197
 mexicanus 197
Microcentrum 207
 laurifolium 207
 retinerve 208
 rhombifolium 207
minor, *Labia* 151
minor, *Melanoplus* 196
minuta, *Diestrammena* 221
minutipennis, *Pezotettix* 192
minutus, *Tridactylus* 258
Miogryllus 246
 verticalis 246
modesta, *Montezumina* 205
modesta, *Symmetropleura* 206
Mogoplistinae 256
Montezumina 205
 modesta 205
 oblongoculata 206

sinaloae 206
morsei, *Melanoplus* 193
muticus, *Anurogryllus* 247
Myrmecophila 257
 pergandei 257
Myrmecophilinae 257

N

nebrascensis, *Neoconocephalus* 210, 211
nebrascensis, *Phoetaliotes* 199
neglectus, *Gryllus assimilis* 246
neglectus, *Hippiscus* 183
Nemobiinae 247
Nemobius 247
 bruneri 250
 canus 248
 carolinus carolinus 251
 confusus 251
 cubensis 250
 palustris 250
 fasciatus 248, 249
 fasciatus 248
 socius 248
 tinnulus 249
 griseus funeralis 250
 griseus 249, 250
 maculatus 249
nemoralis, *Conocephalus* 216
Neoblattella detersa 157
Neoconocephalus 208
 bruneri 211
 ensiger 210
 exiliscanorus 211
 lyristes 210, 211
 nebrascensis 210, 211
 palustris 209
 retusus 209
 robustus crepitans 209, 210
 robustus 210
 triops 209
neomexicana, *Mermiria* 174
Neotettix 170
 bolteri 170
 femoratus 170
Neoxabea 254
 bipunctata 254
nietanus, *Tomonotus* 180
niger, *Ceuthophilus* 243
nigra, *Udeopsylla* 243
nigricans, *Ceuthophilus* 227
nigricornis argentinus, *Oecanthus* 253

nigricornis 253
quadripunctatus 253
nigripes, *Orchelimum* 214
nigropleurum, *Conocephalus* 217
nigrum, *Epilampra* abdomen- 158
niveus, *Oecanthus* 253
noctivaga, *Nyctibora* 158
 sp. near 158
nodulosus, *Ceuthophilus* 227
Nomotettix 166
 acuminatus 166
 borealis 166
 compressus 167
 cristatus 166
 arcuatus 168
 compressus 167, 168
 cristatus 166, 168
 denticulatus 167, 168
 sinuifrons 167
 parvus 166
 sinuifrons 166, 167
Nyctibora holosericea 158
noctivaga 158
 sp. near noctivaga 158
Nyctiborinae 158

O

oblongifolia, *Amblycorypha* 206
oblongoculata, *Montezumina* 206
oblongoculata, *Turpilia* 205
obovatifennis, *Melanoplus* 193, 194
obscura, *Schistocerca* 189
occidentalis, *Caloptenus* 194
occidentalis, *Pezotettix* 194
occultus, *Ceuthophilus* 237, 239, 242
Oecanthinae 251
Oecanthus 251
 angustipennis 253
 exclamationis 252, 253
 fasciatus 253
 latipennis 254
 nigricornis argentinus 253
 nigricornis 253
 quadripunctatus 253
 niveus 253
Oedipoda aequalis 186
 belfragii 184
Oedipodinae 179
olivacea olivacea, *Campylacantha* 189
Orchelimum 211
 agile 213

bradleyi 215
 bullatum 214
 calcaratum 213
 campestre 214
 concinnum 214
 campestre 214
 concinnum 214
 delicatum 214, 215
 glaberrimum 212
 gladiator 213
 longipenne 212
 nigripes 214
 silvaticum 213
 volantum 215
 vulgare 212, 213
orientalis, *Blatta* 157
ornatum, *Acridium* 169
Orocharis 256
 saltator 256
 uhleri 256
Orphulella 176
 maculipennis 176
 pelidna 176
 speciosa 176

P

pachymerus, *Atlanticus* 219
pachymerus, *Thyreonotus* 219
pallidipes, *Ceuthophilus* 227
palustris, *Neoconocephalus* 209
palustris, *Nemobius cubensis* 250
Panchlora cubensis 158
 viridis 158
Panchlorinae 157, 158
parva, *Phlibostroma* 178
Paratettix 170
 cucullatus 170
Parcoblatta 153
 bolliana 154
 desertae 155
 fulvescens 155
 lata 155
 pennsylvanica 153, 156
 uhleriana 153, 155
 unicolor 153
 virginica 154
 zebra 154, 155
Pardalophora 182
 apiculata 182, 183
 discoideus 183
 haldemanii 183

- phoenicoptera 182
 Paroxya 200
 atlantica atlantica 200
 clavuliger 200
 hoosieri 200
 parvipennis, Tettigidea lateralis 171
 parvus, Nomotettix 166
 pelidna, Orphulella 176
 pellucida, Camnula 181
 pennsylvanica, Parcoblatta 153, 156
 pennsylvanicus, Gryllus 246
 pergandei, Myrmecophila 257
 Periplaneta 156
 americana 157, 158
 australasiae 156, 157
 fuliginosa 156, 157
 persimilis, Diapheromera 160, 161
 atlantica, Diapheromera 160
 Pezotettix autumnalis 199
 manca 193
 minutipennis 192
 occidentalis 194
 rusticus 193
 unicolor 194
 viola 194
 viridicrus 192
 viridulus 192
 Phalangopsis gracilipes 229
 robustus 242
 Phaneropterinae 203
 Phasmidae 159
 Phlibostroma parva 178
 quadrимaculatum 178
 phoenicoptera, Pardalophora 182
 phoenicopterus, Hippiscus 182
 Phoetaliotes 199
 nebrascensis 199
 Phrixocnemis 242
 inhabilis 242
 truculentus 242
 Phyllopalpus 255
 pulchellus 255
 Phylloscirtus 255
 pistillata, Scudderia 204
 platyptera, Stethophyma 178
 politus, Ceuthophilus 243
 polymorpha, Tettigidea 171
 ponderosus, Melanoplus 194
 ponderosus 195
 viola 194
 pratensis, Hesperotettix 189
 pratensis, Hesperotettix viridis 189
 Pseudomopinae 153, 157
 pseudonietana, Arphia 180
 Pseudophyllinae 208
 Pseudopomala 173
 brachyptera 173
 Psinidia 185
 fenestralis fenestralis 185
 fuscifrons texana 185
 Pterophylla 208
 camellifolia 208
 pulchellus, Phyllopalpus 255
 pulicaria, Anaxipha 255
 punctulatus arboreus, Melanoplus 196
 punctulatus 196
 puteanus, Hadenocerus 222
 Pycnoscelus 157
 surinamensis 157
- Q**
- quercus, Dendrotettix 199
 quadrимaculatum, Phlibostroma 178
 quadripunctatus, Oecanthus nigricornis 253
- R**
- religiosa, Mantis 159
 retinerve, Microcentrum 208
 retusus, Neoconocephalus 209
 Rhaphidophorinae 220
 Rhaphidorhiza maculata 226
 rhombifolium, Microcentrum 207
 robusta, Udeopsylla 242
 robustus, Phalangopsis 242
 robustus, Daihinia 242
 robustus crepitans, Neoconocephalus 209, 210
 robustus 210
 rotundifolia rotundifolia, Amblycorypha 207
 rubrum, Melanoplus femur-rubrum femur- 197
 rugosus, Hippiscus 181
 rugosus, Hippiscus corallipes 181
 rusticus, Pezotettix 193
- S**
- saltans, Conocephalus 218
 saltator, Orocharis 256
 saxatilis, Trimerotropis 186
 sayi, Diapheromera 161

- Schistocerca* **187**
 alutacea **189**
 americana americana **188**
 damnifica damnifica **188**
 obscura **189**
scriptus, *Ceuthophilus* **227**
scudderi, *Ageneotettix* **178**
scudderi scudderi, *Melanoplus* **194**
Scudderia **203**
 curvicauda **205**
 curvicauda **204**
 furcata furcata **205**
 fuscata **205**
 pistillata **204**
 septentrionalis **204**
 texensis **205**
scudderianus, *Gryllus assimilis* **246**
seclusus, *Ceuthophilus* **226, 227, 236**
septentrionalis, *Scudderia* **204**
silvaticum, *Orchelimum* **213**
silvestris, *Ceuthophilus* **237, 239, 242**
simplex, *Eritettix* **175**
sinaloe, *Montezumina* **206**
sinensis, *Tenodera* **159**
sinuifrons, *Nomotettix* **166, 167**
sinuifrons, *Nomotettix cristatus* **167**
socius, *Nemobius fasciatus* **248**
sordidus sordidus, *Encoptolophus* **181**
sp. near noctivaga, *Nyctibora* **158**
speciosa, *Orphulella* **176**
speciosus, *Hesperotettix* **190**
Spharagemon **184**
 bolli **184**
 collare **184**
 wyomingianum **184**
spicata, *Tettigidea* **172**
spretis, *Melanoplus* **197**
spretus, *Melanoplus* **197**
squamosum, *Cycloptilum* **256**
Stagmomantis **158**
 carolina **158**
Stethophyma **178**
 gracile **178**
 lineatum **178**
 platyptera **178**
strictus, *Conocephalus* **217**
stygius, *Ceuthophilus* **229**
sulphurea, *Arphia* **179**
Supella supellectilium **157**
supellectilium, *Supella* **157**
surinamensis, *Pycnoscelus* **157**
suturalis, *Hippiscus* **181**
Symmetropleura **205, 206**
 laevicauda **205**
 modesta **206**
Syrbula **174**
 admirabilis **174**
- T**
- Tachycines* **221**
 asynamorus **220, 221**
taxodii, *Inscudderia* **205**
tenebrarum, *Ceuthophilus* **22**
tenebrosus, *Tomonotus* **180**
Tenodera **159**
 sinensis **159**
tepidus, *Melanoplus* **194**
terminalis, *Tridactylus* **258**
terrestris, *Ceuthophilus* **226, 227, 229, 230**
testaceus, *Atlanticus* **219**
Tettigidea **171**
 acuta **172**
 apiculata **172**
 armata **172**
 depressa **172**
 davisi **172**
 lateralis **171**
 lateralis **171**
 parvipennis **171**
 polymorpha **171**
 spicata **172**
Tettigoniidae **200**
texana, *Psinidia fuscifrons* **185**
texensis, *Scudderia* **205**
thomasi, *Trachyrachis kiowa* **184**
Thyreonotus pachymerus **219**
tinnulus, *Nemobius fasciatus* **249**
Tomonotus nietanus **180**
 tenebrosus **180**
Trachyrhachis **184**
 kiowa fuscifrons **185**
 kiowa **184**
 thomasi **184**
triangularis, *Acridium* **169**
tricarinatus, *Eritettix* **175**
Tridactylinae **258**
Tridactylus **258**
 apicalis **258, 259**
 illinoisensis **258**
 minutus **258**
 terminalis **258**

Trigonidiinae 255
 Trimerotropis 186
 citrina 186
 maritima 187
 interior 186, 187
 saxatilis 186
 verrucullata 186
 triops, *Neoconocephalus* 209
 truculentus, *Phrixocnemis* 242
 Truxalis 173
 brevicornis 173
 tuberculatus, *Hippiscus* 182, 183
 tunicae, *Melanoplus* 195
 Turpilia 206
 oblongoculata 205

U

Udeopsylla 242
 compacta 243
 nigra 243
 robusta 242
 uhleri, *Amblycorypha* 206
 uhleri, *Ceuthophilus* 236
 uhleri, *Orocharis* 256
 uhleriana, *Parcoblatta* 153, 155
 uhleriana *fulvescens*, *Ischnoptera* 155
 unicolor, *Diestrammena* 220, 222
 unicolor, *Parcoblatta* 153
 unicolor, *Pezotettix* 194
 uniformis, *Ceuthophilus* 227

V

variegatus, *Hippiscus* 181
velii, *Diapheromera* 162
 velii 162

vernalis, *Gryllus* 246
verrucullata, *Trimerotropis* 186
verrucullatus, *Circotettix* 186
verticalis, *Miogryllus* 246
viola, *Melanoplus* 195
viola, *Melanoplus ponderosus* 194
viola, *Pezotettix* 194
virgatus, *Eritettix* 175
virginica, *Parcoblatta* 154
viridicrus, *Pezotettix* 192
viridifasciata, *Chortophaga* 180
viridipes, *Melanoplus* 192
 eurycerus 192
 viridipes 192
viridis, *Dichromorpha* 176
viridis, *Panchlora* 158
viridis pratensis, *Hesperotettix* 189
viridulus, *Pezotettix* 192
volantum, *Orchelimum* 215
vulgare, *Orchelimum* 212, 213

W

walshii, *Melanoplus* 194
williamsoni, *Ceuthophilus* 230
wyomingianum, *Spharagemon* 184

X

xanthoptera, *Arphia* 180
Xiphidion 217

Z

zebra, *Parcoblatta* 154, 155

SUPPLEMENT

DERMAPTERA

LABIIDAE

Vostox Burr

V. brunneipennis (Serveille).—Blatchley (1920) recorded this earwig from southern Illinois on the basis of specimens collected by Mr. Gerhard of the Field Museum. The specimens taken September 29 are from under the bark of a large dead tree and a few from the ground directly beneath, to which no doubt they had fallen when the bark was pulled off.

Olive Branch: Sept. 29, 1909, 3♂, 9♀, 1 juv.; Sept. 30, 1♂, Gerhard, *FM*.

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STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
NATURAL HISTORY SURVEY

THEODORE H. FRISON, *Chief*

Vol. XX

BULLETIN

Article IV

The
Stoneflies, or Plecoptera,
of Illinois

THEODORE H. FRISON



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URBANA, ILLINOIS
JANUARY 1935

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This paper is a contribution from the Section of Insect Survey.

FOREWORD

This report grows out of studies begun in the fall of 1926 when the writer was first impressed with the abundance and variety of the fall and winter stonefly population in Illinois. Field observations coupled with the rearing and collection of stoneflies were focused from 1926 to 1929 chiefly on our fall and winter fauna, resulting in the publication by myself in 1929 of a detailed report concerning the "Fall and Winter Stoneflies, or Plecoptera, of Illinois." After the appearance of this paper attention was directed mainly to the species constituting our spring and summer stonefly fauna and a minimum of effort and time has since been spent in study of the fall and winter species.

The present paper, then, is a summary of our stonefly studies which have been more or less continuous since 1926. For completeness this report has not been limited to the spring and summer forms but includes an entire survey of the plecopteran fauna of Illinois, which makes it possible to present a classification unrestricted by the seasonal idiosyncrasies of species, genera or families. It offers, too, an opportunity to add further data concerning some of the fall and winter species not available at the time of the 1929 paper, and perhaps most important, it enables the presentation of a balanced and comparative picture of the stoneflies of this state.

The writer has been greatly aided during the course of the study by various individuals and by the literature recording the observations and studies of other workers with this group of aquatic insects. I am indebted to Professors P. W. Claassen and J. G. Needham of Cornell university for the privilege of studying the extensive Plecoptera material in the collection of that institution, and for the donation of specimens and many other courtesies; for the loan or donation of material, to Dr. Nathan Banks of the Museum of Comparative Zoology, Cambridge, Mass., Professor Ferris Neave of the University of Manitoba, Winnipeg, Professor Chauncey Juday, University of Wisconsin, Madison, Dr.

D. I. Rasmussen, U. S. Forest Service, Ogden, Utah, Professor H. E. Jaques, Iowa Wesleyan college, Mt. Pleasant, Iowa, and to Dr. R. D. Bird of the Dominion entomological laboratory, Treesbank, Man.

Mr. W. J. Spencer, superintendent of the Sears hydroelectric station at Rock Island, Ill., has greatly facilitated our studies by first indicating to us the accumulation of insect material on bar racks of hydroelectric stations and by allowing us to establish a rearing station on the property under his charge.

A second rearing station was maintained for several years on the property of the Charleston water company, Charleston, Ill., adjacent to the Embarrass river, and I am indebted to them for this privilege.

Within the SURVEY I am indebted to Mr. Carroll Chouinard, editor, for taking care of the many details connected with the publication of this paper, to Dr. H. H. Ross, systematic entomologist, for aid with collection and rearing of material and with the final preparation of this article, and I am especially indebted to Dr. C. O. Mohr, associate entomologist, for his assistance in the collection and rearing of material and most of all for preparation of the many drawings.

Urbana

June 1, 1934

T. H. F.

CONTENTS

	PAGE
FOREWORD.....	iii
STATUS OF THE GROUP.....	281
First studies by Walsh.—List now nearly static.—New classification proposed.—Sex and stage associations.	
STONEFLY STRUCTURE.....	285
Adults.—Nymphs.	
BIOLOGY OF THE ORDER.....	288
Distribution.—Habitat preferences.—Seasonal adjustments.—Habits of adults.—Habits of nymphs.—Enemies.	
COLLECTING, REARING AND PRESERVING STONEFLIES.....	303
Collecting adults.—Collecting nymphs.—Rearing methods.—Preservation of material.	
CATALOG OF SPECIES, INCLUDING CLASSIFICATION, DESCRIPTION, HABITS AND RECORDS OF ILLINOIS STONEFLIES.....	307
Classification.—More homogeneous grouping.—Basis of present division.—New classification of the Plecoptera of North America.—List of species of the Plecoptera of Illinois.—Plates I-XIV illustrating keys.—Key to families of the Plecoptera of North America.—Pteronarcidae.—Taeniopterygidae. Nemouridae.—Leuctridae.—Capniidae.—Perlidae.—Perlodidae.—Chloroperlidae.	
BIBLIOGRAPHY.....	461
INDEX.....	468



SALT FORK RIVER IN PARK AT HOMER, ILLINOIS. Submerged rocks, leaves and debris in the shallows of such a habitat often furnish the collector with nymphs of *Neophasganophora capitata*, *Acroneuria evoluta*, *Neoperla clymene* and *Perlesta placida*.

The Stoneflies, or Plecoptera, of Illinois

THEODORE H. FRISON

STATUS OF THE GROUP

THE STONEFLY FAUNA of Illinois has never attracted more than slight attention from entomologists. This has been partially due to an insistence upon pinning the adults after the manner employed for preserving beetles, butterflies and most other insects—a method which inevitably results in shriveled specimens, to impede recognition of structural characters needed in making identifications and to render them so unattractive that the average entomologist is not interested. Two more conditions foster this neglect of the order: the adults are rarely seen in numbers by those not especially searching for them, and frequently adults and nymphs are not readily and accurately associated except by rearing.

First studies by Walsh.—The one Illinois entomologist who was an outstanding exception to the general attitude was Benjamin Dann Walsh. His major publishings date from 1868, when as first state entomologist he issued the "First Annual Report on the Noxious Insects of the State of Illinois." His paper concerning certain neuropteroid insects in Illinois (1862)¹ contained records and descriptions of stoneflies collected by himself mostly in the vicinity of Rock Island, and as Needham and Claassen (1925) state, "he collected so assiduously that the vicinity of Rock Island, Ill. has remained until recently one of the best worked fields in America for the neuropteroid groups." In the present paper the records and descriptions of Walsh are recognized or placed in synonymy upon the basis of a few specimens named by him and now in the SURVEY collection or studied by the author, also upon the placements given them by

¹See bibliography, p. 461.

Needham and Claassen (1925) as a result of their study of types in the Museum of Comparative Zoology, Cambridge, Mass., and upon our studies of the stonefly fauna now existing at Rock Island and in Illinois in general, which give strong circumstantial evidence concerning the species occurring there in former years. I have placed in synonymy or recognized with much confidence all of the species of Walsh with one exception, *Chloroperla nana*, and this I believe may eventually be proved to be the same as *Isoperla minuta* Banks.

A revised tabulation of the species recorded by Walsh from the vicinity of Rock Island in 1862 gives us a present list of 15 species. In the tabulation of species by states as given by Needham and Claassen (1925), Illinois is credited with 14 species, but since two species of *Pteronarcys* are listed whereas all our evidence indicates but one, this list of 1925 includes only 13 species. If all the Walsh records had been placed by Needham and Claassen their list would have given 17 species for this state. Our studies to date give us a total of 36 species of stoneflies for Illinois plus at least two and possibly a third species as yet known only as nymphs and not placeable to species at present time—a list more than double those of Walsh or Needham and Claassen.

The status of two *Acroneuria* nymphs and another nymph which I am tentatively placing as *Neophasganophora* need to be definitely established. Two of these, one *Acroneuria* and the *Neophasganophora*, are certainly species which are additions to our list. The second *Acroneuria* nymph now unnamed may represent a light phase of a species already reared and known, but there is also a possibility that it may be new to our list.

List now nearly static.—Our studies have been thorough and comprehensive enough over the past eight years from the standpoint of various watersheds, seasonal timing and quantity to prove that few additional species can be added to the present Illinois list. This is further supported by our personal studies in Minnesota, Wisconsin and Indiana, and from material collected by others in Iowa, Missouri, Oklahoma and Tennessee. Material from these seven states indicates a stonefly fauna which cannot contribute many records to our Illinois list.

Although Illinois contains only about one-fifth of the 200+ species of stoneflies known at the present time from North America north of Mexico, every family which I recognize is included within our borders except one—Peltoperlidae. Likewise, most of the North American genera are represented. From this it will be seen that a consideration of the family and generic groupings of the Illinois species has involved practically a study of the North American fauna as a whole, and I have been

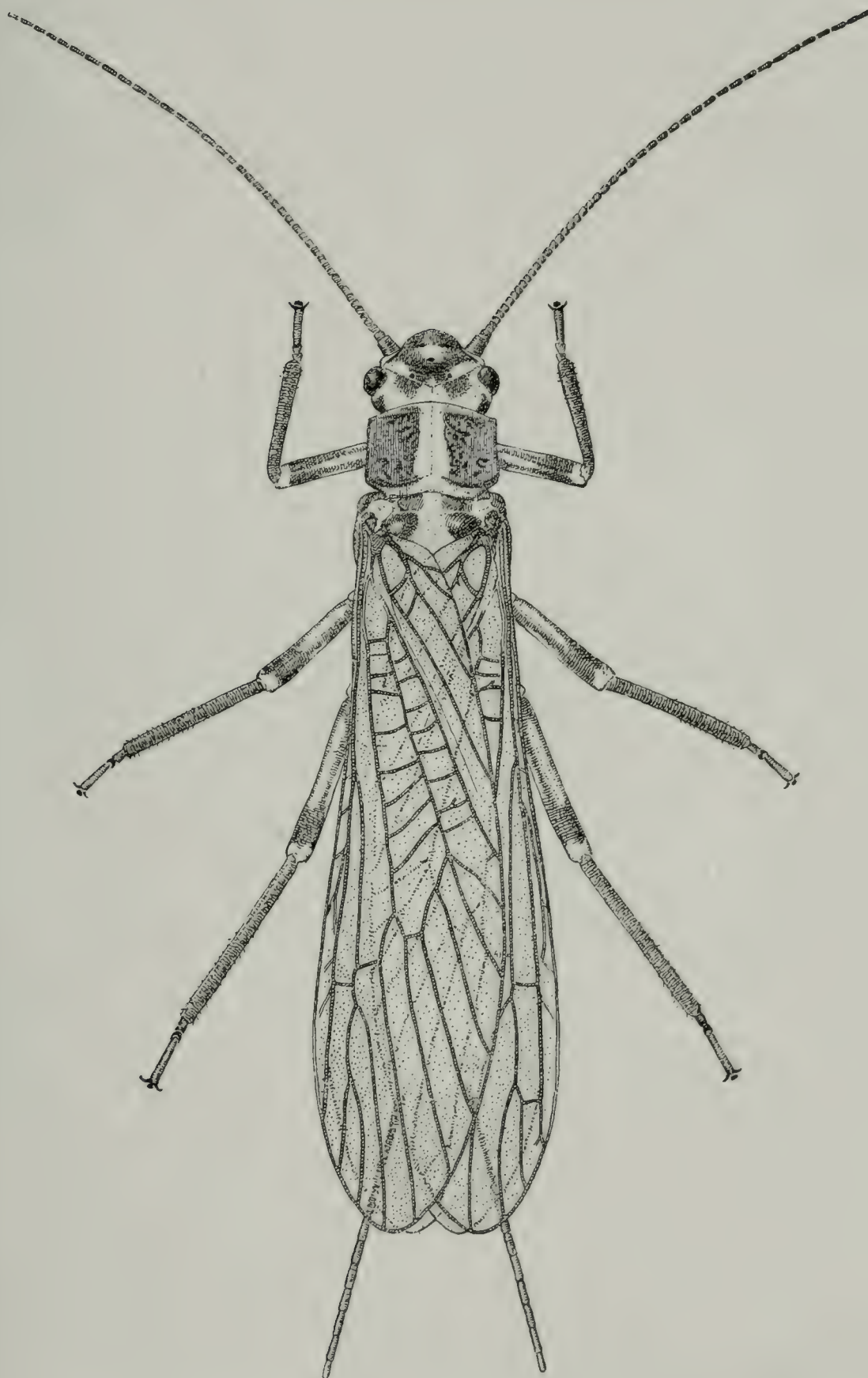


Fig. 1.—REPRESENTATIVE ADULT OF AN ILLINOIS STONEFLY, *Isoperla confusa*, female.

compelled to think of my Illinois classification in such terms. Due to the kindness of various individuals throughout this country I have been able to study many species not found in Illinois and most species of particular importance in formulating a classification that is comprehensive.

New classification proposed.—Consideration of both nymphs and adults in these studies has convinced me that our past classifications contain many unnatural elements, particularly when many characters are evaluated in place of the few whose investigation has often become a fetish. As a result of this close study of adults as well as nymphs, in the laboratory as well as in the field, I am proposing a classification (p. 310) which



Fig. 2.—VENTRAL VIEW OF ADULT FEMALES. **a.**—(Left), *Taeniopteryx nivalis*, showing scars on coxae where tracheal appendages were attached to nymph. **b.**—(Right), *Strophopteryx fasciata*, showing lack of scars on coxae as indicating no tracheal appendages on nymph.

departs from previous classifications of our North American stonefly fauna in concepts of families and genera. In some instances these changes coincide with the viewpoints of certain European students which have not been adopted by American students; in others they are new groupings or the remolding of old ones. It should be understood however that the classification here used is one independently formulated without regard to any special school, and is an attempt to develop a classification which can be supported by biology as well as by the morphology of both adults and nymphs. How well the present classification fits this ideal will rest upon the results of future studies based upon a broad viewpoint.

With this in view I should like to repeat a statement from my previous report (1929) on the Illinois group, as follows: "The insect life of our inland streams affords a most interesting and profitable field for investigation; and the sooner we learn to place and evaluate this fauna correctly, the sooner we will be in a position to formulate conclusions

and generalizations of importance in our efforts to understand our aquatic resources and to forward their intelligent use."

Sex and stage associations.—One of the objectives of the study of the stoneflies of Illinois has been the definite recognition and characterization of the various species found within the state. So that our concept of the various species might rest upon a secure foundation much effort has been spent to insure the correct association of males with females in the adult stage, and the nymphs or immature stages with their proper adults. Although such associations are often evident from a study of preserved specimens, due to aggregations of morphological characters in common, or other circumstantial evidence, conclusive proof of the correct associations of adult males and females and of nymphs with adults has been sought by rearings and careful field observations. Definite proof has been afforded by the capture of mating pairs. Although it is true that some of these associations between nymphs and adults have been correlated previously and correctly by other workers outside of Illinois, well over half of the associations brought to light in this investigation are new and a good many of the remaining half are conclusively established for the first time.

This investigation has forcibly impressed upon the writer the great benefits to be gained by the correlation of field investigations and laboratory research. It is by such companion studies only that the sexes and immature stages of some species can be properly associated for the first time, and the true taxonomic value of obscure specific characters revealed. There is a thrill and a practical angle too in being able to visualize the preserved bodies that pass in review under our microscope as living entities once engaged in a struggle for existence after the manner of their endowment by nature and in their natural environments. A correctly named and preserved entomological specimen has its usefulness and place in our modern scheme of things in the same way as has some standard unit of measurement in the custody of a bureau of standards of weights and measures, and perhaps more so because of the difficulty of adequate characterization. It is not however until such a specimen is associated with some knowledge of its place in nature that recognition of it can assume general significance or be of practical value.

STONEFLY STRUCTURE

ADULTS and nymphs of stoneflies present few formidable obstacles such as a specialized terminology or complex morphological features, to hinder their identification. A minimum of study of either an adult or nymph will reveal that we are dealing with a generalized form which possesses many features common to neuropteroid insects in general. It does not require

much imagination to see in the stonefly, too, evidences of kinship with an insect so often used in the laboratory as an introduction to insect morphology—the grasshopper.

Adults.—The adults, fig. 1, in general have practically the same characters as the nymphs. This similarity has not been utilized in the past as much as it should or could be used. Careful study of an adult makes possible a prediction concerning the general structure of the nymph and *vice versa*. In general even the mouthparts of the adults are similar to those of the nymphs, except in the case of some species where certain

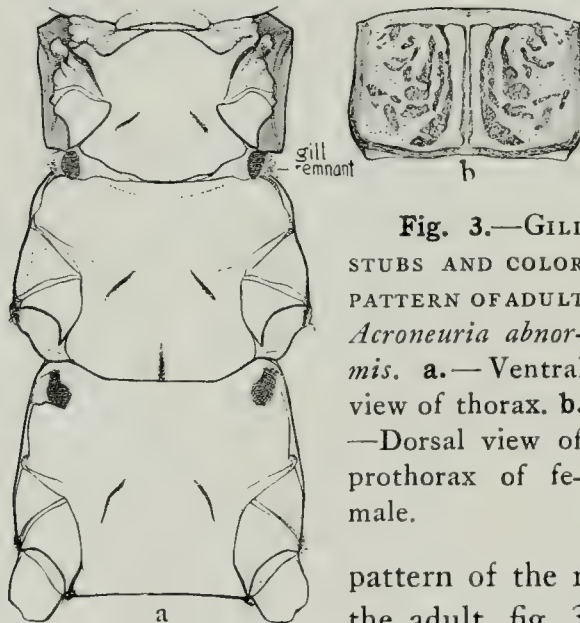


Fig. 3.—GILL STUBS AND COLOR PATTERN OF ADULT *Acroneuria abnormis*. **a.**—Ventral view of thorax. **b.**—Dorsal view of prothorax of female.

structures of the mouthparts are not functional. The number and location of nymphal gills are almost invariably indicated in the adult by some scar, fig. 2, or remnant, fig. 3a, of a gill. Descriptions of adults in the past have almost entirely overlooked the importance and usefulness of these vestigial structures and even detailed morphological studies of adults have been deficient in this respect (Clark 1934). Even the

pattern of the raised rugosities on the pronotum of the adult, fig. 3b, is sometimes recognizable in the nymph. The wing pads of the nymphs, too, are often at a state of development where the venation of the adult wing can be perfectly interpreted, as stated by Claassen (1931). Likewise in a nymphal male about to produce an adult the genital structures may sometimes be seen through the nymphal skin to enable one to identify the species.

Nymphs.—The importance or value of characters used in the identification of stonefly nymphs varies greatly among the species, genera or families. In some instances color pattern and general size are sufficient for recognition of the species whereas in other instances the mouthparts, gills, etc. are very essential. In fig. 4, which represents a hypothetical stonefly nymph, practically all terms used in this paper are associated with the structures to which they refer. Other figures in plates III, V, VII, XII, prepared to show greater detail of certain structures, are labeled to show the terms associated with them. (See p. 316 and following.)

In most cases the sex of Illinois stonefly nymphs can be determined by the condition of the setal fringe on the posterior margin of the eighth abdominal segment. In the males the fringe is continuous, and in the

females interrupted, as is exemplified in *Neophasganophora capitata*, figs. 319, 320, p. 411.

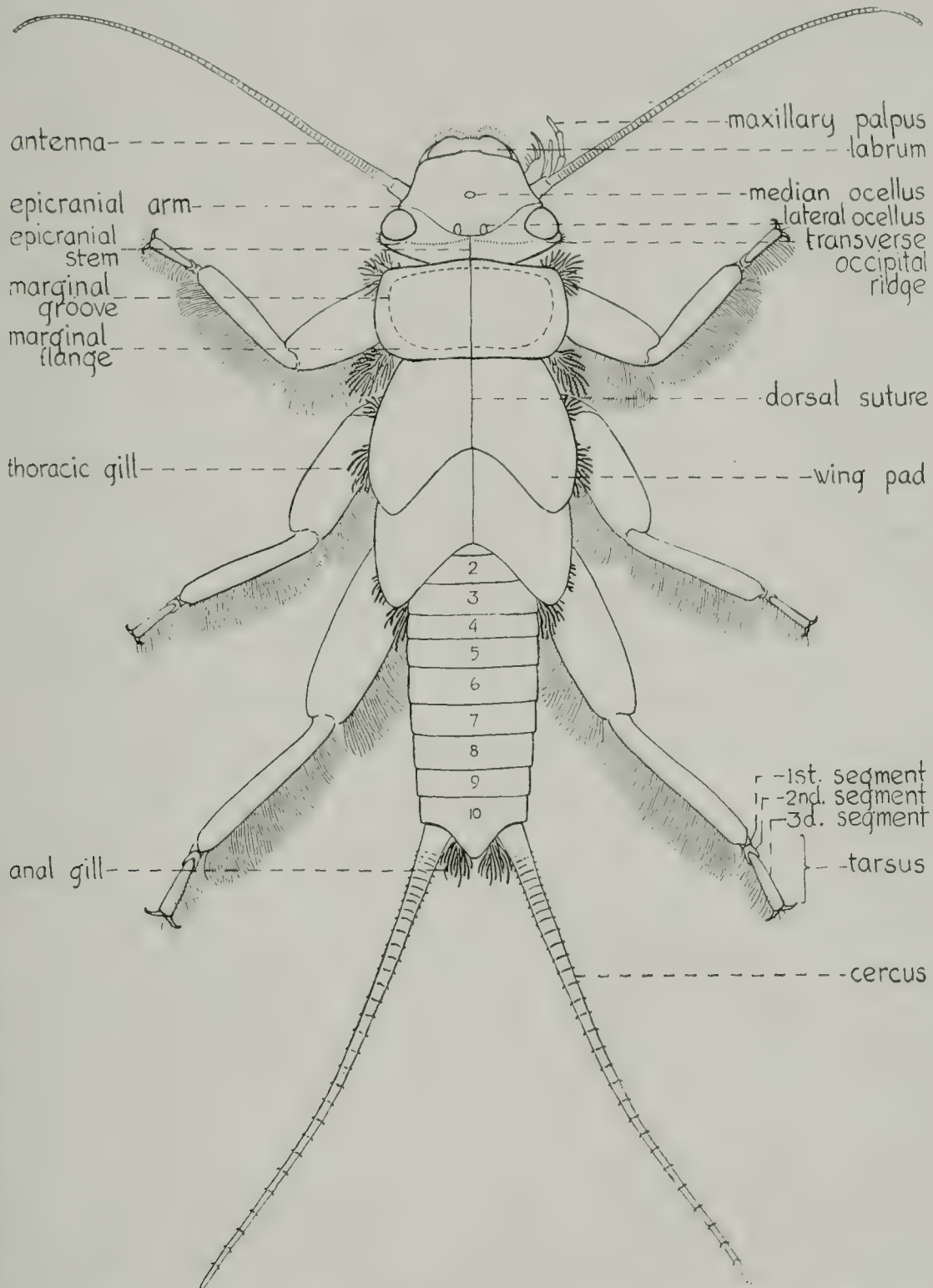


Fig. 4.—STONEFLY PARTS. Dorsal view of a constructed stonefly nymph, with principal parts used in identification labeled.

The adults differ most noticeably from the nymphs in respect to identification by the addition in most all species of the fully developed

wings, oftentimes the development of complex and characteristic genital structures, figs. 195, 242, the loss of fully developed gills where present in the nymphs, and sometimes degenerate, nonfunctional mouthparts. The specialized terminology of the wing veins is shown in fig. 171 and that of the genitalia in fig. 326. Other structures have approximately the same terminology as in the nymph. (See pp. 324, 326, 330, 418.)



Fig. 5.—MAP OF ILLINOIS. Each dot represents one or more localities at which stoneflies were collected during the course of this study.



Fig. 6.—MAP OF ILLINOIS, SHOWING DISTRIBUTION OF *Perlesta placida*. Each dot represents one or more localities at which this insect was taken.

The types of all new species or varieties described in this paper are deposited in the collection of the ILLINOIS STATE NATURAL HISTORY SURVEY.

BIOLOGY OF THE ORDER

THE following are brief comparative accounts of some aspects in the life of stoneflies found in Illinois which are of general biological or ecological interest. More specific data appear in connection with the remarks concerning each species.

Distribution.—The stoneflies of this state, although comparatively poor in number of species for an order, follow the rule of other large

units of closely related species in displaying differences in zoögeographical distribution within our boundaries. Analysis of our fauna in comparison with other states shows it to be made up largely of species which may be classed as common to most states in the Mississippi valley and eastern North America, together with a few elements more characteristic of areas to the north and southeast of our borders. The Rocky mountain or



Fig. 7.—MAP OF ILLINOIS, SHOWING OCCURRENCE OF *Togoperla media*. This species has been taken but once in the state, in the Mississippi river.



Fig. 8.—MAP OF ILLINOIS, SHOWING DISTRIBUTION OF *Allocapnia forbesi*. This species is restricted to the Ozark uplift in extreme southern Illinois.

extreme western element in our stonefly fauna is entirely lacking, unless it is represented by two species of nymphs which have not as yet been associated with a name, or by a pair of adults whose general distribution outside Illinois is unknown.

It is likely that many of our Illinois stoneflies can be collected in any part of the state where streams of the size and character required by the nymphs are available, fig. 5. Under this grouping we may list our most common species, *Acroneuria abnormis*, *Allocapnia granulata*, *Allocapnia vivipara*, *Isoperla bilineata*, *Neoperla clymene*, *Perlesta placida*, fig. 6, *Strophopteryx fasciata* and *Taeniopteryx nivalis*. One of our species, *Togoperla media*, has been taken only once in extreme northwestern Illi-

nois, fig. 7, and our studies in Wisconsin indicate that it is a more northern form becoming most numerous in the colder waters of extreme northern Wisconsin. Several species, such as *Allocapnia pygmaea*, *Allocapnia forbesi*, fig. 8, *Leuctra claasseni* and *Isoperla decepta*, represent more south-eastern or southern forms.

Instances of discontinuous or sporadic distribution are afforded by such species as *Allocapnia recta*, *Allocapnia illinoensis*, *Hydroperla varians* and *Isoperla mohri*. Our records for *Hydroperla harti* indicate that this

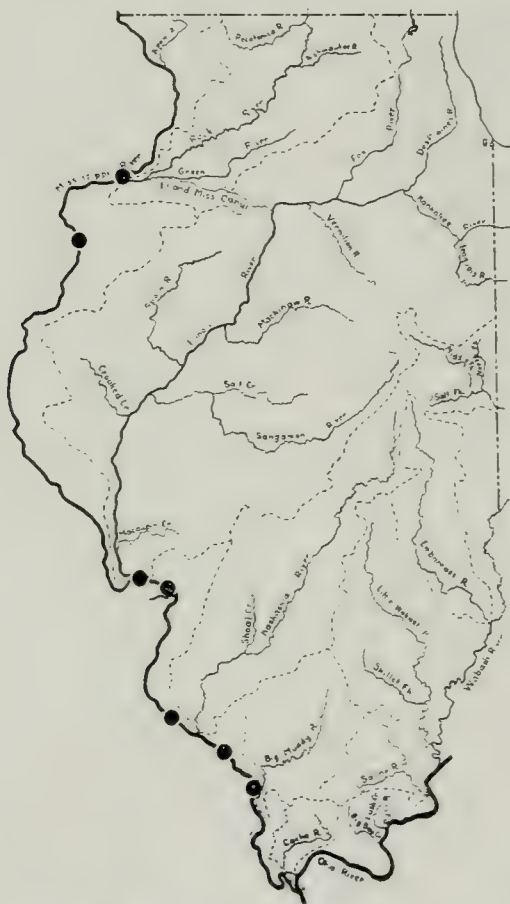


Fig. 9.—MAP OF ILLINOIS, SHOWING THE DISTRIBUTION OF *Hydroperla harti*. This species has been taken from only seven localities in Illinois, but these are distributed the length of the Mississippi river.

species has an extreme affinity for the main course of the Mississippi river, fig. 9. Two other interesting local distributional areas as we now know them are as follows: the abundance and concentration of *Hydroperla crosbyi* and *Isoperla minuta* in rich soil areas which in an earlier and natural state were once mainly prairie, and our failure to find *Isoperla richardsoni* elsewhere than in the Rock river. *Taeniopteryx parvula* is another species seemingly with a preference for the larger watercourses of the state without regard for latitude or longitude. Some species, such as *Nemoura venosa*, *Atoperla ephyre*, *Perlinella drymo*, *Acroneuria ruralis*, *Acroneuria internata*, *Acroneuria arida*, *Pteronarcys nobilis* and *Isoperla confusa*, have such a spotty distribution that local differences, river sizes, etc. are probably the determining factors in their distribution in this state, rather than watershed areas or differences in zonal preference.

Habitat preferences.—In discussing the fall and winter stoneflies the writer (1929) went into considerable detail to develop the idea that marked and different habitat preferences were displayed among the nymphs of the members of the fall and winter fauna. Expansion of our field investigations to include those forms emerging as adults in the spring and summer months has brought added emphasis to the fact that species competition among the stoneflies is eliminated to a great extent throughout



Fig. 10.—TYPICAL SMALL STREAM HABITAT OF ILLINOIS STONEFLIES. This tributary, which flows into the Salt Fork near Oakwood, afforded collection of *Allocapnia mystica* and *A. vivipara*.

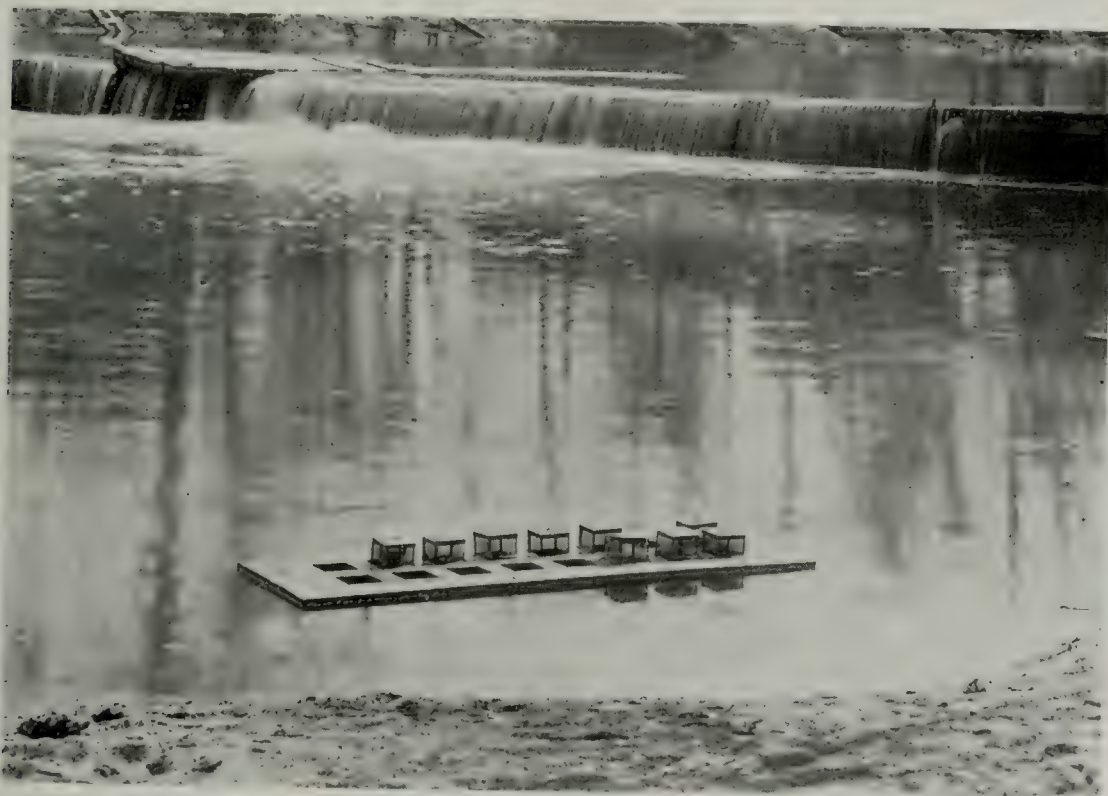


Fig. 11.—RAFT OF REARING CAGES IN NATURAL HABITAT. Shallows below dams such as this on the Salt Fork at Homer yield *Strophopteryx fasciata* and *Neophasganophora capitata*.

the entire year by the differences in habitat preferences of the nymphs. Of course I do not mean that two species of nymphs belonging to the same general seasonal succession and having practically the same feeding habits never occur together. As a rule however the combination of seasonal succession, feeding habits and habitat preferences is such as greatly to reduce competition.

Many species, such as *Allocapnia recta*, *Allocapnia illinoensis*, *Allocapnia mystica*, *Allocapnia pygmaea*, *Isoperla decepta*, *Isoperla mohri* and



Fig. 12.—TYPICAL LARGE RIVER HABITAT OF ILLINOIS STONEFLIES. At such places along the Ohio near Elizabethtown *Taeniopteryx nivalis* and *Acroneuria abnormis* were collected.

Leuctra claasseni, are found in Illinois only in very small streams, fig. 10. Others, such as *Pteronarcys nobilis*, *Acroneuria ruralis*, *Taeniopteryx parvula* and *Isoperla bilineata*, are found mostly in the large rivers, fig. 12. One factor accounting for this habitat preference is the fact that large stoneflies requiring more than one year to complete their development are excluded from small streams which often go dry. Medium sized streams, fig. 13, usually offer the best variety of stoneflies because they are often frequented by the large as well as the smaller species. Within certain limits one can generalize to the effect that stream size preferences on the part of stoneflies are correlated with body sizes of the nymphs or adults; or the larger the stonefly the larger the stream preferred, and *vice versa*.

Stream size is however only one of the elements involved in habitat preferences. Carnivorous species must frequent those places teeming with other forms of aquatic invertebrate life and herbivorous species demand places where their food is abundant. Some species prefer the faster water of a stream whereas others prefer sluggish water. In my experience the nymphs of *Neophasganophora capitata* are most abundant in rapid water

where the river bed is rocky, or in rapids below dams, such as exists at Homer, fig. 11, Oregon and Sterling, Illinois. *Acroneuria ruralis*, on the other hand, is usually found in trash in deeper water having less current.

Many species, such as *Hydroperla crosbyi*, *Taeniopteryx nivalis*, *Isoperla confusa* and various species of *Allocapnia*, congregate in masses of leaves which lodge against rocks or vegetation growing in or protruding from the water, fig. 14. These same species also frequent the shallow margins of streams where they hide under the leaves which collect in the



Fig. 13.—TYPICAL MEDIUM SIZED STREAM HABITAT OF ILLINOIS STONEFLIES. At such places along the Embarrass near Charleston and in similar streams throughout the state, *Acroneuria internata*, *Pteronarcys nobilis* and *Hydroperla crosbyi* are to be found.

water along the banks. The nymphs of *Perlesta placida* and *Neoperla clymene* exhibit in my experience a preference for hiding away in the algae and other forms of aquatic vegetation growing on and among the rocks in fairly rapid water.

The type of bottom of a stream, as already indicated in what has been said regarding certain species, is an important factor in governing the concentrations of different species of stonefly nymphs. *Isoperla decepta* and *Isoperla mohri* have been found only in small streams with a considerable amount of sand bottom and *Isoperla minuta* in abundance only in small streams rich in organic matter and with muddy bottoms.

From the standpoint of habitat preferences the adults of stoneflies are less noteworthy than the nymphs because of their restricted life span and type of activities. The adults are usually found close to the waters in which the nymphs develop but at times fly considerable distances away from water. The nocturnal forms are frequently attracted to lights. The egg laying habits of the adult females do have a direct bearing on con-

centrations of nymphs; females of species frequenting the larger or medium sized streams fly into or drop their egg masses into the water where the nymphs will find conditions most satisfactory, and females of many of the smaller species which inhabit very small streams crawl into the water at points where the nymphs thrive best.

Seasonal adjustments.— In a discussion of the seasonal adjustments of stoneflies we are forced to consider mainly the adults. This is because the nymphs are difficult to find when in their first instars, the duration



Fig. 14.—TYPICAL MEDIUM SIZED STREAM HABITAT OF ILLINOIS STONEFLIES. Leaves and debris at the end of branches trailing in the water along Big Creek near Oliver and in similar streams throughout the state are the favorite habitat of *Isoperla confusa* and *Hydroperla crosbyi*.

of the egg stages is practically unknown, and due to some species requiring more than a year to reach maturity there is an overlapping of generations. The adults however present an exceptional picture of seasonal adjustments and we are able with the data in our possession to give a very adequate picture for this order as a whole. Detailed information relating to collection dates for the species is presented in connection with the accounts or descriptions of each, beginning page 334.

One of the most striking features of the seasonal succession of stoneflies in Illinois is the existence of a varied and abundant fall and winter fauna which gives us a continuous seasonal range of species from late fall until late summer. Most large groups of insects familiar to the general entomologist or layman emerge as adults in the spring, summer or fall and during the winter months hibernate in some stage or other. The fact that about one-third of the species of the order Plecoptera in Illinois emerge as adults, mate, feed and carry on all essential activities for the perpetuation of their species in the coldest months of the year is indeed

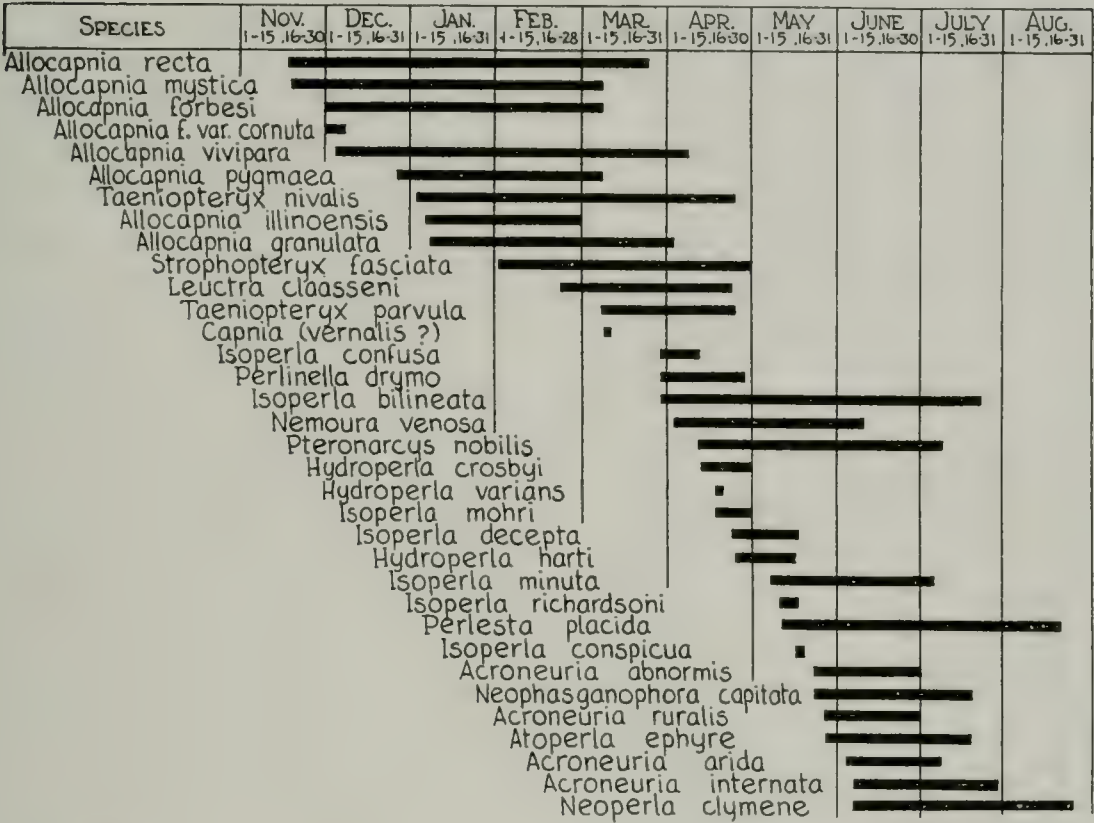


Fig. 15.—SEASONAL DISTRIBUTION. Adults of the 34 species of Illinois stoneflies charted here are timed to occur almost throughout the year. Two species listed in this work are omitted from the graph because of insufficient data.

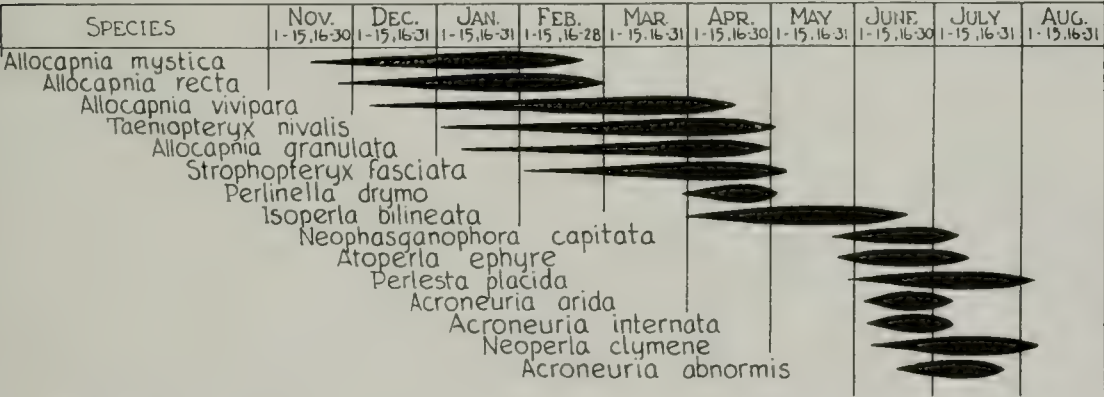


Fig. 16.—SEASONAL SUCCESSION. The widest part of the spindle indicates the time of maximum abundance of adults for each of these 15 stonefly species which occur in the vicinity of Oakwood, Illinois.

unique among the major insect orders of the state, and something meriting more emphasis in general texts. I have previously commented (1929) on this as follows: "Such phenomena cannot fail to excite wonder and forcefully bring to mind the wonderful adaptiveness of the insect world—one of the chief reasons why insects so outnumber all other kinds of animal life."

In figure 15 I have plotted the seasonal distribution of the adults

of 34 species of Illinois stoneflies based upon our collections and rearing data. For the most abundant and common species the seasonal ranges indicated on the graph adequately picture the time of occurrence of the adults. Two of the 36 species now definitely listable by species name in our Illinois faunal list have been left out of the graph because seasonal data are lacking, or because we have not collected or reared them. Figure 15 shows the extraordinary scattering of adults throughout almost the entire year, the concentration of herbivorous species during the colder months and the tendency for the species most abundant and widely distributed to occur as adults over a comparatively long period.



Fig. 17.—STONEFLIES FEEDING ON ALGAE FROM TREE TRUNK. These adult females of *Allocapnia mystica* were observed December 27, 1928, near Oakwood, Illinois.

It should be explained, of course, that these long seasonal ranges for the adults of certain species as shown in fig. 15 are subject to contraction somewhat in proportion to the size of the territory, especially north to south, covered by the available data. Climatic differences between northern and southern Illinois are sufficient to hasten the date of emergence in the southern end of the state and to retard it in the north.

To illustrate that the seasonal succession of adults is a very pronounced phenomenon even in a restricted locality, another graph, fig. 16, is presented, illustrating the seasonal timing of adults of 15 species which occur in the vicinity of Oakwood, Ill., a small town near the Salt Fork river not far from Urbana and readily accessible at all times of year. This graph confirms the above general conclusions drawn from fig. 15. If this graph differs in any way, it is that the winter species are more apt to be found as adults during a longer period than the summer forms—something more obscured in fig. 15 because of the more extreme north and south latitudes considered. The spindles of fig. 16 indicate the extent and duration of specific abundance and further point out the scattering throughout the year of species mentioned in connection with the first graph. Although many species overlap, the timing of their maximum abundance differs.

As our studies of the fauna of Illinois progress it will be most interesting to compare one order of aquatic insects with another and to correlate the whole from an ecological point of view. The thoroughness of our quantitative and qualitative collecting, enabling comparative studies, is indicated by the numerous localities which have provided the data for this paper, as shown in fig. 5.

Habits of adults.—Already discussed in part, the adult habits will again be referred to in the catalog of species, beginning page 307. Here then it may be profitable merely to summarize general information which may be of interest and use to those who are not special students of the stoneflies.

FEEDING.—I have discussed (1929) in considerable detail the feeding habits of the fall and winter species and shown that adults belonging to the genera *Allocaonia*, *Taeniopteryx* and *Strophopteryx* are herbivorous and that blue-green algae are a favorite food, fig. 17. Observations since then definitely expand this group of herbivores to include *Leuctra*, *Nemoura* and at least two species of *Isoperla*. The remaining genera, and partly *Isoperla*, are nonfeeders.

By and large, if we separate the genera on the basis of whether they feed in the adult stage we have one group of feeders which contains the fall and winter stoneflies, except for a few *Isoperla*, and a second group which are nonfeeders, recruited from the spring and summer forms. The adults which feed are possessed of well formed and sclerotized mandibles, and in those which do not feed the mandibles are flabby. Thus a study of the mouthparts of the adult is almost a sure clue as to whether the adults feed.

In discussing *Isoperla*, a generic name which I use in a broad sense, I have indicated that future studies will probably show the necessity for breaking up this single genus into several. The fact that *Isoperla* as now used contains species which do and do not feed in the adult stage, correlated with mouthpart development, is evidence in this direction. Roughly, the nonfeeders correspond to the Systellognatha or Subulipalpia, as compared later in explaining the classification introduced in this paper, p. 308, and the feeders correspond to the Holognatha or Filipalpia.

The fact that many stonefly adults feed is not so generally understood and much of our general literature is in need of change because it conveys the impression that stoneflies do not feed in the adult stage.

Another interesting point in connection with the feeding habit of adults is that diurnal forms are liable to be feeders whereas the nocturnal forms are most liable to be the nonfeeders. The two species of *Isoperla*, *minuta* and *decepta*, which I have observed to feed, are diurnal whereas

such nocturnal forms as *I. bilineata* are nonfeeders. This correlation holds well for the fall and winter forms because they are all diurnal species, but it breaks down more in the spring and summer forms. For instance *Neophasganophora capitata* is active during the day but I have never observed it feeding and its mouthparts do not indicate such a habit. The same also applies to Illinois species of the genera *Hydroperla*, *Perlinella* and certain species of *Isoperla*. Most true nocturnal forms however, such as *Acroneuria* and *Neoperla*, are nonfeeders and it so happens that *Pteronarcys*, morphologically belonging to the group of species constituting the fall and winter fauna, is essentially nocturnal and a nonfeeder.

MATING.—The time of stonefly mating depends upon whether the adults are diurnal or nocturnal. It begins as soon as both sexes appear,

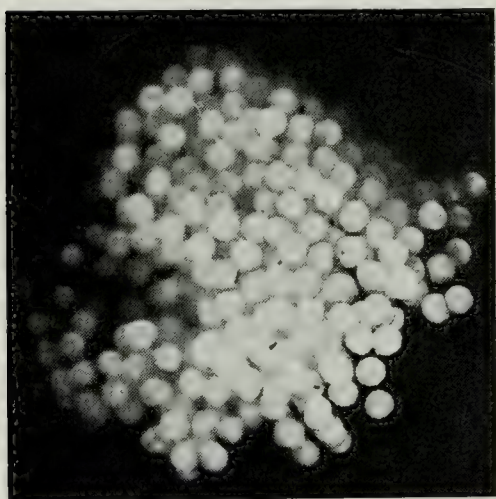


Fig. 18.—EGGS OF *Taeniopteryx nivalis*. Each egg mass of this winter stonefly may contain as many as 1400 or more eggs.

the males usually being somewhat protandrous, and reaches its height in the warmer days or nights during the time of maximum abundance. As noted in the case of the fall and winter forms (Frison 1929), the freshly emerged females of the spring and summer forms are most sought by the males. Sometimes a single female is surrounded by a large number of males—an evident aid to collecting in the case of diurnal species. The courtship of the sexes of *Allocapnia* has been previously described by myself (1929). Except for variations due to morphological differences in genital

structures the mating habits of most stoneflies are essentially alike. As far as I have been able to ascertain mating never takes place while the adults are flying and hence differs in this respect from some aquatic insects which mate while flying over the surface of the water where the eggs are deposited.

OVIPOSITION.—Marked differences exist in the egg laying habits of various species. The habits of such genera as *Taeniopteryx*, *Strophopteryx* and *Allocapnia* were described in detail in my previous paper, from which the following paragraphs are taken:

“A marked difference in egg laying habits was found to exist in the Oakwood region between the species of fall and winter stoneflies inhabiting large streams and those living in small brooks. Those preferring large streams, such as *T. nivalis*, *S. fasciata* and *A. granulata*, usually deposit their eggs directly in the river, particularly at rapids where the swirling

and turbulent water sparkles in the sunshine on bright days. A short time previous to the deposition of the eggs, the females of these species seek resting places on bridges, trees and other objects near the river and by a rhythmic contraction of the abdomen gradually force from the oviduct, a little at a time, a matrix containing many eggs. One such egg mass produced by a female of *T. nivalis* contained 1407 eggs, fig. 18; and it is probable, judging by their size, that most egg masses of *T. nivalis*, *S. fasciata* and *A. granulata* contain approximately the same number.

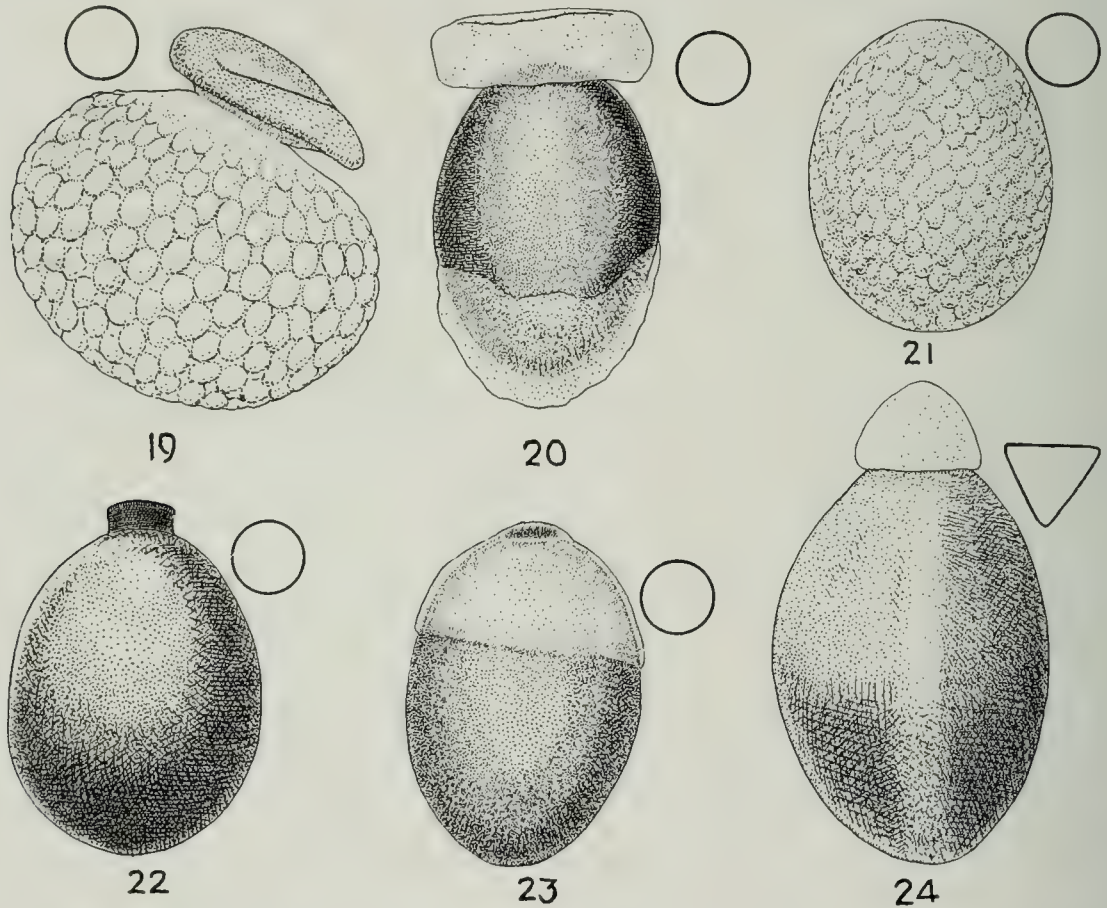
"These three species differ as a rule in the manner of holding the egg mass while it is being formed. The female of *S. fasciata* keeps her abdomen extended for its full length almost horizontally, or parallel with the object on which she rests, so that the egg mass, which is rather irregular in shape, is partly concealed beneath the abdomen. *T. nivalis*, and to a still greater extent *A. granulata*, bend the end of the abdomen upward and forward, so that the usually globular egg mass is much more easily seen, and a superficial observation might cause one to think it was being carried on the back of the abdomen.

"By the simple expedient of catching females with egg masses and submerging them in water, it was found that the egg masses soon fall from the female, the matrix holding together the numerous eggs dissolves, and the individual eggs separate. Subsequent observations showed that the females could voluntarily release the egg masses when ready to do so, without awaiting the disintegrating effect of the water. It is possible that the egg masses are sometimes dropped into the water by the females without alighting upon it, but in the instances witnessed at close range, the females lighted upon the surface of the water, almost instantly released their egg masses and then flew up and away again. No doubt some females of *Taeniopteryx* and *Strophopteryx* crawl with their egg masses to the water's edge and deposit their eggs, and I have seen such a performance upon the part of a female of *A. granulata*.

"Much evidence was obtained in the Oakwood area to show that the females of *A. recta*, *A. mystica* and *A. vivipara* rarely if ever lay their eggs while flying over the water, but rather that they deliberately crawl into the water at its edge or at other places where stones, sticks and leaves are partly submerged. Several times I found females of *A. recta* carrying egg masses into the water to release them. Since the females of *A. vivipara* are normally short winged in this part of Illinois, it is easy to understand why some of them do little if any flying above the small streams in which they lay their eggs, but in southern Illinois where there is a strong tendency for the females of this species to develop long wings, there is no such restriction upon their flying. There seems to be no good reason why *A. recta* and *A. mystica* do not fly more than they do."

Observations since 1929 confirm my belief then that *A. vivipara* is not viviparous under natural or most field conditions. Many *vivipara* females have since been observed carrying their egg masses as do other *Allocapnia*.

The spring and summer forms produce egg masses as do all the fall and winter forms, but the eggs constituting these masses are usually



Figs. 19-24.—EGGS OF STONEFLIES, SIDE VIEW WITH CROSS SECTION IN OUTLINE. 19.—*Pteronarcys nobilis*. 20.—*Neophasganophora capitata*. 21.—*Isoperla bilineata*. 22.—*Perlesta placida*. 23.—*Acroneuria abnormis*. 24.—*Hydroperla harti*.

fewer, darker and have a harder shell. In fact, as Needham and Claassen (1925) have indicated by illustrating the eggs of certain species, the eggs often are an excellent guide as to the identity of the species. The eggs vary in size, in shape and in reticulations, figs. 19-24, and might well be the subject of a special study.

Although in many groups it will be impossible to distinguish species on the basis of the eggs alone, they must not be overlooked as sources of evidence for natural groups of related species. *Hydroperla*, proposed as a new genus in this paper, has an egg triangular in cross section, fig. 24, which differs markedly from other species such as *Neophasganophora capitata* and *Togoperla media*, formerly included in the same genus. The eggs were not the basis of my generic splitting in the first place but they

certainly do not gainsay the propriety of this division. Where the eggs have not become specialized, a similarity may exist among many genera without meaning much more than common ancestry of some sort, but markedly different eggs obviously can never support arguments for close relationships.

The spring and summer forms of stoneflies, in my experience, never crawl into the water with their egg masses as do certain *Allocahnia* and *Nemoura*, but drop their egg masses into the water while flying over it. The abdomen, too, is rarely turned upwards and backwards to such a degree that the egg mass appears as being carried on the back of the abdomen as in the case of *Allocahnia* and to a lesser extent in *Taeniopteryx*.

Habits of nymphs.—The name stoneflies indicates some connection between these insects and stones, but it is in many cases without significance. The nymphs of some species do hide under or among stones in streams and the adults are sometimes found on stones at times when the nymphs are crawling out of the water and ready to produce adults. In many instances however the nymphs are not associated with stones and the adults are found anywhere that there is food if they are species which feed, or where they can find a protected place to rest during their inactive hours. In other words, the term *stoneflies* as applied to these insects in Illinois is pretty much a misnomer.

FEEDING.—In my paper of 1929 I stated in regard to the nymphs: "It appears . . . that all of the fall and winter stoneflies of Illinois are herbivorous." Studies since then give no cause for modifying this statement. However, among those species which because of time of emergence I have roughly termed the spring and summer forms, there is variation in respect to food habits.

Under older classifications the Perlidae, containing the most common spring and summer species, was a mixture of genera having either carnivorous, herbivorous or omnivorous habits. In the classification used in this paper the Perlidae comprises a group of species essentially belonging to the late spring and summer fauna, and having in the nymphs carnivorous habits. The Perlodidae, as here separated, are apparently carnivorous, or at least the nymphs I have studied are so. The Chloroperlidae, also separated from Perlidae in this paper, show a mixture of feeding habits. The one species of *Chloroperla* from Illinois is herbivorous, as apparently are *Isoperla bilineata* and *I. minuta*. Other species of *Isoperla* however, such as *duplicata*, *mohri*, *confusa*, *decepta* and *richardsoni*, are carnivorous or at least at times have such habit. The genus *Isoperla* in the broad sense used in this paper has every indication of being an unnatural unit and it is hoped that in future attention will be drawn to morphological characters which will clearly separate the various complexes.

EMERGENCE.—It has been my observation that diurnal species of stoneflies emerge mostly during early morning and that nocturnal species emerge late in the evening or at night. I know of no instance in which the adults pop out of the water free of the nymphal skin as in some aquatic groups, or have another molt after leaving the water and flying as in the case of the Ephemera. In all instances the nymphs crawl out of the water on rocks, vegetation or any object protruding out of the



Fig. 25.—SMALL RIVER HABITAT OF ILLINOIS STONEFLIES. Various species of the winter group develop in such streams and on sunny days crawl up and congregate on bridges.

water. There, after a short rest, the nymphal skin splits down the back, as has been described by the writer (1929), and the soft adult crawls out. After a short time the wings and body structures harden and the adult crawls or flies away.

DEVELOPMENT.—Our method of rearing adults from nymphs was aimed at securing accurate association of adults with nymphs, with a minimum of time and effort, and scant attention was paid to the number of developmental instars. In fact, except for the observations of Samal (1923), Schoenemund (1912) and Wu (1923), very few reliable data have been gathered concerning the number of instars in stonefly nymphs. These students indicate that there are many instars, Wu giving 22 for *Nemoura vallicularia*, Schoenemund 36 for *Perla cephalotes* and Samal 22 instars for *Perla abdominalis*.

The size classes of nymphs and seasonal occurrences offer some clue, however, to the total time of the life cycle. In Illinois it appears that

all species of *Allocapnia*, *Nemoura*, *Leuctra*, *Taeniopteryx*, *Strophopteryx*, *Perlesta*, *Neoperla*, *Isoperla* and *Hydroperla* require a year for their life cycle. *Pteronarcys* and *Acroneuria* certainly require a longer time and probably two or three years.

Enemies.—I can add to a discussion of stonefly enemies very little more than what I stated in 1929, except to record a case of an adult of *Perlesta placida* being caught and eaten by a robin when this species of stonefly was exceedingly abundant at Oregon, Ill.

COLLECTING, REARING AND PRESERVING STONEFLIES²

SINCE stonefly nymphs live in streams and the adults on land, quite different methods are necessary for their capture. The nymphs are usually easier to collect because they occur over a longer period of the year, are more numerous and have a more restricted habitat than the adults.

Collecting adults.—The variety of ways in which stonefly adults may be collected is surprising in spite of the few species in our fauna and their restricted habitat distribution. During the warmer days of fall, winter and early spring, adults of the winter species may be found on concrete bridges, fence posts and other objects near the streams in which the insects develop. The attraction of light colored bridges such as that in fig. 25 for stonefly adults has enabled us to get a large number of records of the winter species very easily, simply by driving along highways and stopping to examine each bridge. On the warmest of winter days tree trunks covered with green algae attract considerable numbers of stoneflies. In addition to these higher places the adults may be found under stones and trash near the water's edge and frequently in numbers on trees and logs that have fallen partly into a stream. Beating heavy brush hanging over a stream will sometimes dislodge adults and knock them into the water, from the surface of which, since they float, they may be picked with ease.

The smaller and more numerous spring species, such as members of *Perlesta* and *Isoperla*, may be collected by sweeping the foliage along the banks of rivers and streams. This method will also net some individuals of the larger species, such as *Hydroperla* and *Acroneuria*, but these may be found more easily by examining likely hiding places, such as sweet clover heads and stems, bunches of weeds and willows near the river. A thorough search of piling, piers and bridges will be found profitable for practically all species of the summer as well as for the winter group.

Lights attract a considerable number of the summer forms, such as *Isoperla bilineata*, *Pteronarcys nobilis*, certain species of *Acroneuria* and

² This section is the contribution of H. H. Ross, systematic entomologist, ILLINOIS STATE NATURAL HISTORY SURVEY.

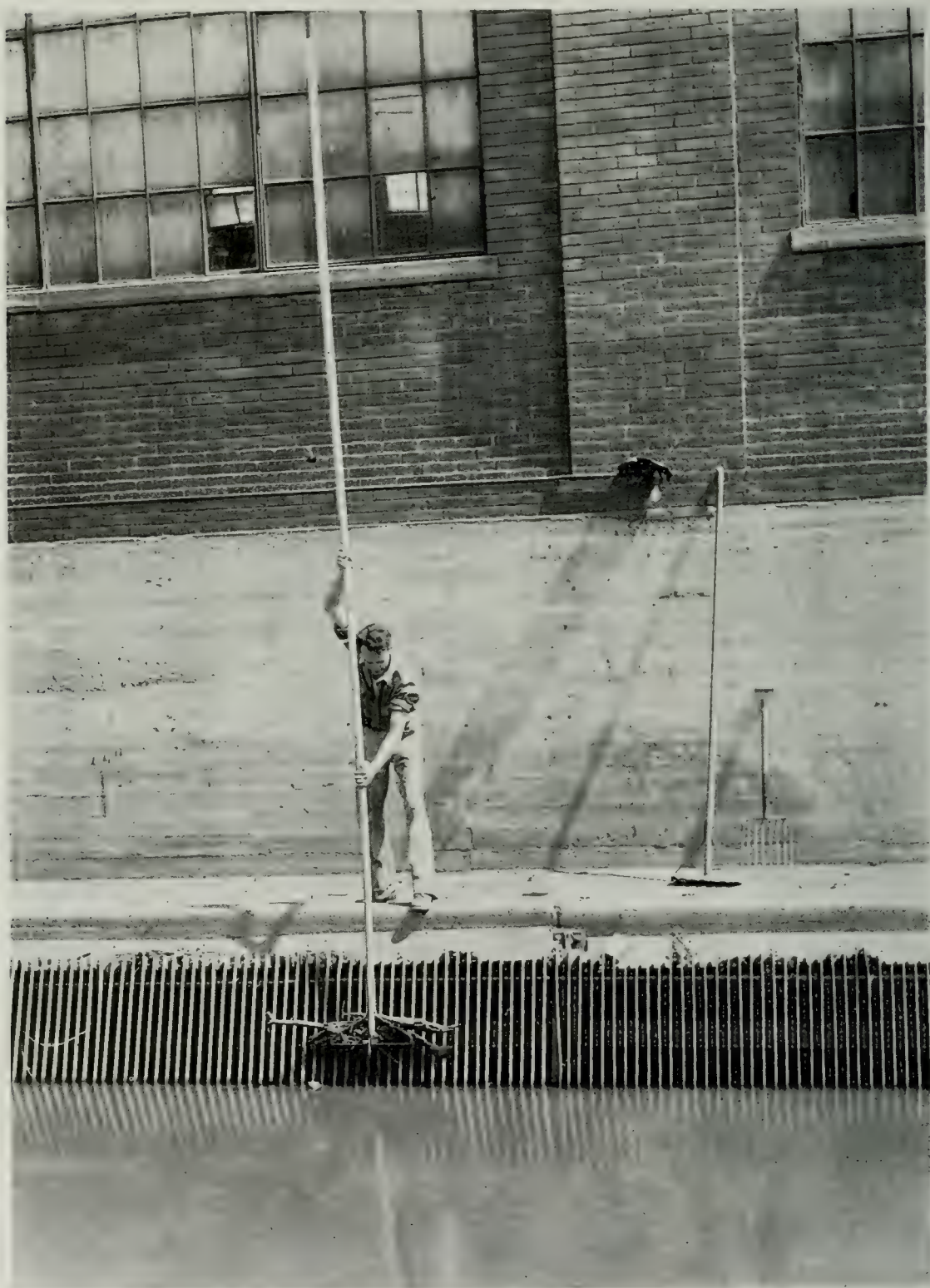


Fig. 26.—PORTION OF A BAR RACK AT HYDROELECTRIC PLANT ON THE ROCK RIVER AT ROCK ISLAND. Debris raked up from the bases of these racks supplies many stonefly nymphs, especially in *Acroneuria* and *Isoperla*.

others. In Illinois specimens have been collected at lights five miles from the nearest streams. Sometimes working with lights is the only profitable method of obtaining large numbers of a species.

Collecting nymphs.— Since the nymphs are entirely aquatic their collection is simplified compared with that of the adults, which are terrestrial. In Illinois the nymphs are restricted to the cleaner and less polluted streams with fair current. The various species have both a definite habitat preference and a definite seasonal appearance. For this reason collecting should be done in streams of all sizes, and several times during the year. Some species occur only locally so that it is advisable to include all possible streams, no matter how similar they look, in the collecting schedule. In the smaller streams the nymphs are usually found in masses of leaves either matted on the bottom, packed against stones or other objects projecting partly out of the water or gathered into knots at the ends of branches trailing in the water as in fig. 14.

Some of the larger species occurring in rivers have been secured in large numbers from debris raked up from the foot of the bar racks of hydroelectric plants, fig. 26. It was discovered at Rock Island in the spring of 1928 that nymphs of practically every species occurring in the river lodge in the mass of waterlogged leaves, branches and trash which gather at the bottom of these bar racks. Similar collecting since in the Rock and Kankakee rivers has afforded series of many large river species which can be obtained only rarely by other means. It is doubtful if random collecting could possibly have provided sufficient material for the rearing and adequate study of some of these species.

In the Mississippi river another type of good collecting place has been found. Nymphs of some *Acroncuria* species congregate in large numbers under the stone slabs at the end of wing dams which jut out into the swifter part of the stream.

Since 1926, when this study was begun, collecting trips have been made periodically over the state in order to complete a thorough survey of Illinois stoneflies. The trips were planned so that each portion of the state was visited in late fall, late winter and several times during spring and early summer. At each trip every kind of habitat was visited and as much material as possible was secured. This evidence was gathered to bring out the exact distribution of species within the state, the seasonal succession of these species, differences in time of appearance from south to north and details of ecological preferences.

Rearing methods.— The methods used during this study were aimed at obtaining full grown or nearly full grown nymphs for rearing so that the time of handling and observation would be reduced to a minimum. No attempt was made to discover such facts as rate of growth or number of instars, the only object being the correlation of nymphs and adults of the same species. The ease and certainty of many rearings was made possible by retention of almost all the nymphal characters in the cast

skin upon emergence of the adult. Because of this the association of a single adult with the nymphal skin from which it emerged constituted positive evidence of the specific identity of nymph and adult.

For the winter stonefly groups such as *Allocapnia* and *Strophopteryx* the following procedure was found very satisfactory. Several full grown nymphs were placed in a small tin with a few wet leaves; the tins were kept tightly covered, insuring a moist chamber, and in these small cages the nymphs usually completed their last growth and emerged as adults. With these winter groups the method was very successful due primarily to the ease of obtaining large numbers of nymphs which were on the verge of becoming adults and in many instances of finding pure cultures of one species in a stream. *Isoperla decepta* also was reared in this manner.

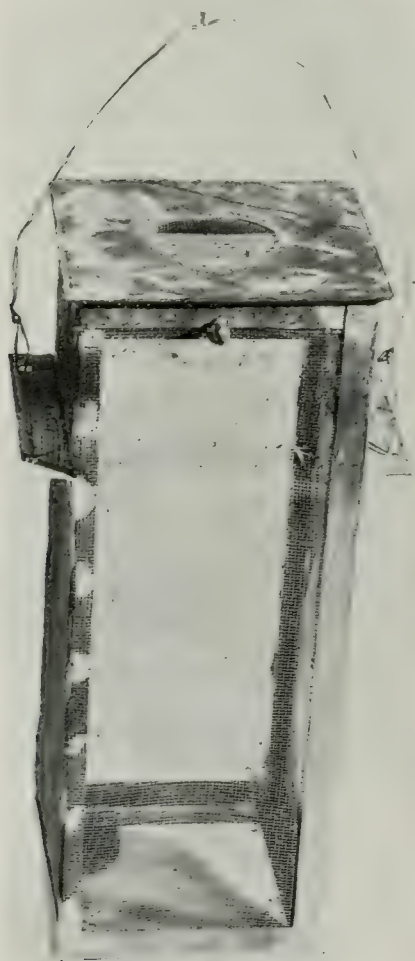


Fig. 27.—STONEFLY REARING CAGE. These cages made of copper strip and fine wire mesh are dropped into holes in large rafts and allowed to float in the natural habitat of the stoneflies.

Several of the larger species, especially members of the genus *Acroneuria*, were reared in a similar fashion. During the adult emergence season bar racks of hydro-electric plants were visited at night when the nymphs were crawling up the bars and out of the water to transform into adults. Each of these nymphs was placed in a separate cage until transformation had taken place. The adult was then placed in a smaller and more conveniently handled container with its cast skin until the full adult color was attained. The adult and cast skin were then preserved together in fluid. A night's work during the height of the emergence season sometimes netted 10 to 40 specimens reared in this manner.

Many species were raised in cages suspended in the water by a raft as in fig. 11. The cages were constructed as shown in fig. 27; 12 inches high by $4\frac{1}{2}$ inches square, made of fine mesh copper screen with a removable top set into the cage and secured by two screws, one at each side. A bracket running the width of the cage and projecting three-quarters of an inch from it was soldered on two opposite sides of the cage 3 inches from the top. Wooden rafts 6 feet long by 2

feet wide were constructed with 16 holes $4\frac{3}{4}$ inches square, in two rows. The cages were lowered into these, and were suspended by the brackets so that three-quarters of the cage was under water. The immersed portion of the cage was furnished with leaves and litter from the stream bed, after which the nymphs of a certain species of stonefly were placed in it. The raft with its laden cages was anchored in running water. A large number of species was reared in this way, including members of *Isoperla*, *Nemoura* and practically all the larger species.

Preservation of material.—Both nymphs and adults have been preserved in fluid, preferably 80 per cent ethyl alcohol. If stoneflies are pinned the bodies shrink to such an extent that it is impossible to make out genitalic and other characters by which they are classified. Only a small amount of material should be put in a vial and the fluid ought to be changed after the first day. This will prevent a large amount of discoloration and blackening.

A 3 dram vial 65 mm. high and 17 mm. wide, with a ring neck has been found very convenient for all species. It will hold a single specimen of the largest species and a large number of the small species. Valuable small specimens are put in a small shell vial; this is filled with fluid, plugged with cotton and dropped plugged end down into a 3 dram vial; the larger vial is then filled about three-quarters full of fluid and corked. This combination furnishes a safe housing for small types and dissected parts.

Labels bearing full collecting data should be put inside each vial; specimens without such information are practically worthless. Vials should be checked once a year, at which time discolored fluid may be changed and new corks or additional fluid may be added where necessary.

CATALOG OF SPECIES

INCLUDING CLASSIFICATION, DESCRIPTION, HABITS AND RECORDS
OF ILLINOIS STONEFLIES

Classification.—The classification of families used in this report does not agree with that of any other North American student of stoneflies. The one I am proposing here follows the work of such European students as Klapalek (1909b), Rousseau (1921) and Schoenemund (1928) in recognizing the breaking up of the old Nemouridae into the families Taeniopterygidae, Leuctridae, Capniidae and Nemouridae, and the former Perlidae into Perlodidae and Perlidae. In addition to accepting Pteronarcidae, as all students dealing with our fauna have done, this classification accepts the further segregation of Chloroperlidae from the Perlidae as previously divided by Rousseau, and the new family Peltoper-

lidae of Claassen (1931). In other words I am convinced that the lumping of all our North American species of Plecoptera into four families, namely the Capniidae, Nemouridae, Pteronarcidae and Perlidae, conceals many relationships and gives us families of a very heterogeneous composition. Most of our American students have studied only the adults and then based their conceptions of the larger units mainly on wing venation and a few other characters. Study of the nymphs brings to light many additional characters which are valuable guideposts to relationships.

More homogeneous grouping.—The present classification is believed to contain numerous elements of strength when evaluated either from the standpoint of adults or nymphs. Wing venation, genital structures, mouthparts, presence or absence of gills, and many other structures have been considered. One of the strongest arguments for the arrangement given here is that this classification based upon structure conforms to biological habits of the stoneflies as well. Although we are confronted with more major groups or families, each family is more homogeneous in habits or from any other point of view. There is also the confirmatory evidence of the nymphs which under the family arrangement here proposed form more homogeneous groups than is the case under the old classification. In the Perlidae, for instance, as formerly used we had a large group of carnivorous and herbivorous nymphs, some with gills entirely lacking and others with copious gills, and adults of numerous types and patterns. A great deal of this heterogeneity is removed by the division of the old Perlidae into three families—the Perlidae, Perlodidae and Chloroperlidae.

It is obvious to any serious student of the Plecoptera of North America that two main lines of descent are represented. One of these lines includes the Pteronarcidae, Peltoperlidae, Taeniopterygidae, Nemouridae, Leuctridae and Capniidae, and has been styled as the suborder Holognatha by Enderlein (1909) and as the Filpalpia by Klapalek (1909b). The other main line is represented by the families Perlidae, Perlodidae and Chloroperlidae, and has been called the suborder Systellognatha by Enderlein (1909), the Subulipalpia by Lestage (1921), and Setipalpia by Klapalek (1909b). Certain peculiar families of the southern hemisphere, particularly from Australia, New Zealand and Chile, best studied by Tillyard (1921), fall within the Holognatha or Filpalpia.

Enderlein and Klapalek have based their suborders upon two different characters but both achieve about the same combination of families. Enderlein based his two major divisions upon whether the adults had well developed or rudimentary mandibles. This does not always hold in the same genus, as illustrated by well developed functional mandibles in *Isoperla decepta* and the flabby nonfunctional mandibles of *I. bilineata*. Nevertheless Enderlein's character for division is fundamentally strong. Klapalek

lek's principle of division was whether or not the terminal palpal segments were successively more slender or approximately as thick as the basal ones. Here again there is some inconsistency in the groups but fundamental relationships are linked with this character.

Basis of present division.—I believe that the best and most fundamental character for the segregation of these two groups consists in the type of mouthparts in general. One group composed of the Taeniopterygidae, Nemouridae, Leuctridae, Capniidae, Pteronarcidae and Peltoperlidae possesses a labium with the paraglossae and glossae extending forward about the same distance and arranged alongside of one another in the same horizontal plane, figs. 115-119, p. 320. Peltoperlidae is perhaps the farthest from this type of those families mentioned. Roughly this is the Holognatha of Enderlein and the Filipalpia of Klapalek.

The other group is composed of the Perlidae, Perlodidae and Chloroperlidae, which possesses a labium with the paraglossae extending much farther forward than the glossae, the latter deeply inset below and between the paraglossae so as to appear almost as basal segments of them, figs. 120-143, p. 320. This is a group approximately equivalent to the Systellognatha of Enderlein and the Subulipalpia of Klapalek.

Within each of these main lines of descent we see a serial progression of genera or species from a generalized to a more specialized type. In the Holognatha or Filipalpia, the family Pteronarcidae in North America is to my mind the more generalized type and the Leuctridae and Capniidae the more specialized types. In the Systellognatha or Subulipalpia the Perlidae seem to me to represent the more generalized type and the Chloroperlidae the specialized type. This opinion is formulated after consideration of the morphological details of both adults and nymphs, and also of their habits. To my mind the Chloroperlidae, Capniidae and Leuctridae appear to be groups still in a stage of active evolution.

Recently Neave (1934) has described a new genus of the Nemouridae (*s. lat.*) by the name of *Megaleuctra*. Since it has several characters in common with *Nemoura*, *Leuctra* and *Taeniopteryx*, I do not consider it evidence against recognition of these groups as families. I consider *Megaleuctra* as belonging to the family Leuctridae, and its characters common to *Nemoura* and other genera just mentioned as indicating its place in the Holognatha or Filipalpia where all these genera belong. If it did not have these characters it could not be a Nemouridae in the old sense.

Neave (1934) has also given us further information about another little known species named *Capnia brevicauda* Claassen. This species is placed by Neave in Capniidae but attention is called to its "nemourid affinities." I consider this species a member of the Leuctridae.

Although this paper centers around the Illinois stonefly fauna, it has been necessary to consider family and generic classifications from the standpoint of the North American or world fauna as a whole, as evidenced by my remarks already given. A skeleton of this new classification down to genera appears below, followed by the list of species known to occur in Illinois.

NEW CLASSIFICATION
OF THE PLECOPTERA OF NORTH AMERICA

PLECOPTERA	{ <i>HOLOGNATHA</i> <i>or</i> <i>FILIPALPIA</i>	PTERONARCIDAE.....	{ Pteronarcys Pteronarcella
		PELTOPERLIDAE.....	{ Peltoperla
		TAENIOPTERYGIDAE...	{ Taeniopteryx Strophopteryx Taenionema Doddsia
		NEMOURIDAE.....	{ Nemoura
		LEUCTRIDAE.....	{ Leuctra Eucapnopsis Megaleuctra Perlomyia
	{ <i>SYSTELLOGNATHA,</i> <i>SUBULIPALPIA</i> <i>or</i> <i>SETIPALPIA</i>	CAPNIIDAE.....	{ Capnia Allocapnia Capnura
		PERLIDAE.....	{ Atoperla Perlinella Neoperla Perlesta Acroneuria Neophasganophora Togoperla
		PERLODIDAE.....	{ Perlodes Isogenus Hydroperla
		CHLOROPERLIDAE.....	{ Chloroperla Isoperla Paraperla Kathroperla Alloperla

LIST OF SPECIES
OF THE PLECOPTERA OF ILLINOIS

PTERONARCIDAE**Pteronarcys** Newman*Pteronarcys nobilis* Hagen, p. 336**TAENIOPTERYGIDAE****Taeniopteryx** Pictet*Taeniopteryx nivalis* (Fitch), p. 341*Taeniopteryx parvula* Banks, p. 345**Strophopteryx** Frison*Strophopteryx fasciata* (Burmeister),
p. 347**NEMOURIDAE****Nemoura** Latreille*Nemoura venosa* Banks, p. 349**LEUCTRIDAE****Leuctra** Stephens*Leuctra claasseni* Frison, p. 354**CAPNIIDAE****Capnia** Pictet*Capnia* ♀ (*vernalis* Newport?), p. 356**Allocaupnia** Claassen*Allocaupnia forbesi* Frison, p. 363*Allocaupnia forbesi* var. *cornuta*
Frison, p. 363*Allocaupnia granulata* (Claassen),
p. 364*Allocaupnia illinoensis* Frison, p. 365*Allocaupnia mystica* Frison, p. 366*Allocaupnia pygmaea* (Burmeister),
p. 367*Allocaupnia recta* (Claassen), p. 367*Allocaupnia vivipara* (Claassen),
p. 370**PERLIDAE****Atoperla** Banks*Atoperla ephyre* (Newman), p. 377**PERLIDAE**—CONT'D**Perlinella** Banks*Perlinella drymo* (Newman), p. 380**Neoperla** Needham*Neoperla clymene* (Newman), p. 381**Perlesta** Banks*Perlesta placida* (Hagen), p. 386**Acroneuria** Pictet*Acroneuria abnormis* (Newman),
p. 391*Acroneuria arida* (Hagen), p. 395*Acroneuria internata* (Walker),
p. 401*Acroneuria ruralis* (Hagen), p. 403*Acroneuria* sp. *a*, p. 405*Acroneuria* sp. *b*, p. 407**Neophasganophora** Lestage*Neophasganophora capitata* (Pictet),
p. 409**Togoperla** Klapalek*Togoperla media* (Walker), p. 412*Togoperla* sp. *a*, p. 414**PERLODIDAE****Hydroperla** Frison*Hydroperla crosbyi* (Needham and
Claassen), p. 419*Hydroperla harti* Frison, p. 423*Hydroperla varians* (Walsh), p. 426**CHLOROPERLIDAE****Chloroperla** Newman*Chloroperla cydippe* Newman, p. 431**Isoperla** Banks*Isoperla bilineata* (Say), p. 437*Isoperla clio* (Newman), p. 439*Isoperla confusa* Frison, p. 441*Isoperla conspicua* Frison, p. 445*Isoperla decepta* Frison, p. 447*Isoperla minuta* (Banks), p. 453*Isoperla mohri* Frison, p. 455*Isoperla richardsoni* Frison, p. 459

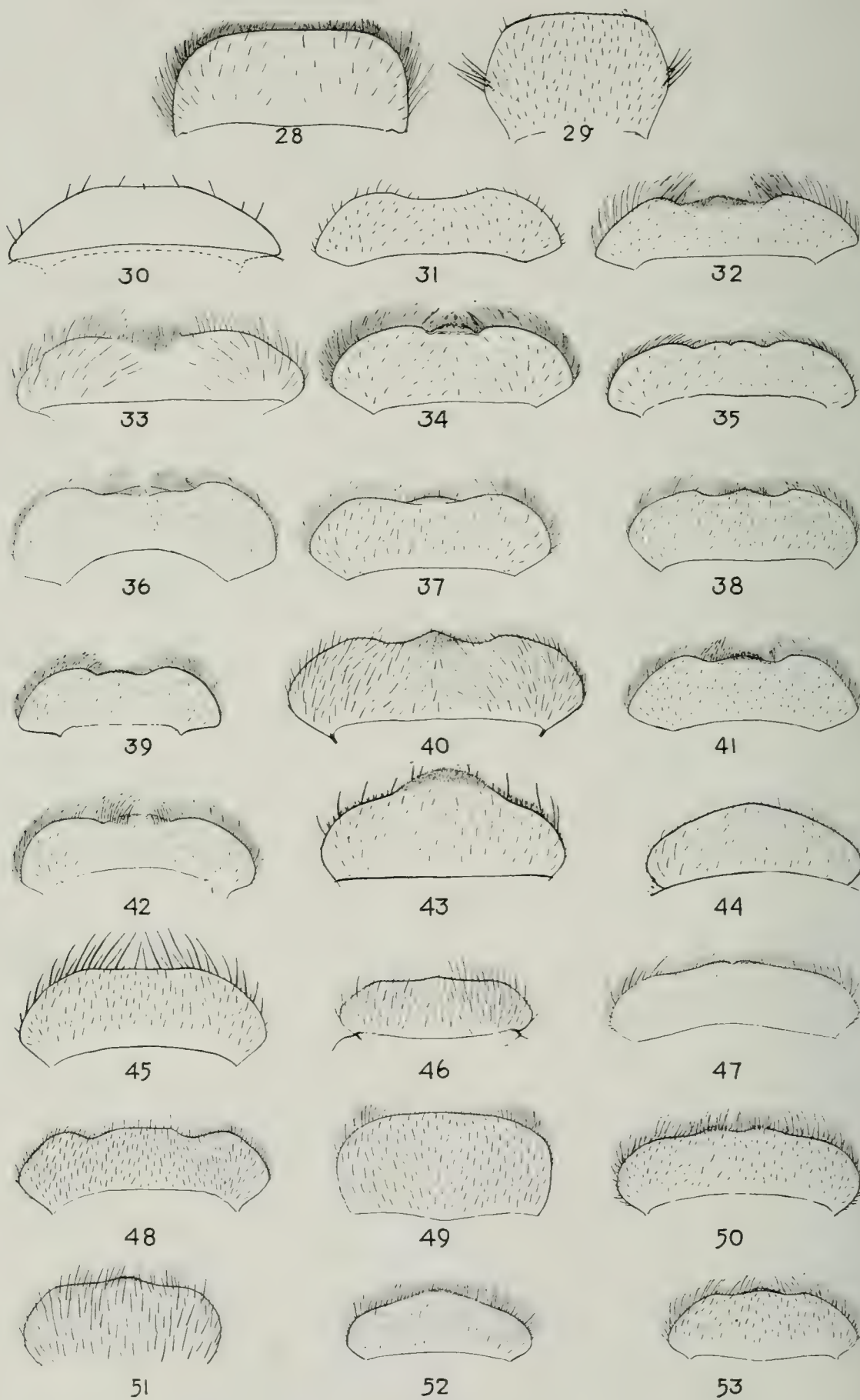


PLATE I

PLATE I

DORSAL VIEW OF LABRUM OF NYMPH

- Fig. 28.—*Pteronarcys nobilis*, male.
Fig. 29.—*Nemoura venosa*, female.
Fig. 30.—*Atoperla ephyre*, female.
Fig. 31.—*Perlinella drymo*, female.
Fig. 32.—*Neoperla clymene*, female.
Fig. 33.—*Perlesta placida*, female.
Fig. 34.—*Acroneuria abnormis*, female.
Fig. 35.—*Acroneuria arida*, female.
Fig. 36.—*Acroneuria internata*, female.
Fig. 37.—*Acroneuria ruralis*, female.
Fig. 38.—*Acroneuria* sp. a, female.
Fig. 39.—*Acroneuria* sp. b, female.
Fig. 40.—*Neophasganophora capitata*, female.
Fig. 41.—*Togoperla media*, male.
Fig. 42.—*Togoperla* sp. a, female.
Fig. 43.—*Hydroperla crosbyi*, female.
Fig. 44.—*Hydroperla harti*, female.
Fig. 45.—*Chloroperla cydippe*, female.
Fig. 46.—*Isoperla bilineata*, female.
Fig. 47.—*Isoperla clio*, female.
Fig. 48.—*Isoperla confusa*, female.
Fig. 49.—*Isoperla decepta*, female.
Fig. 50.—*Isoperla duplicata*, female.
Fig. 51.—*Isoperla minuta*, female.
Fig. 52.—*Isoperla mohri*, female.
Fig. 53.—*Isoperla richardsoni*, male.

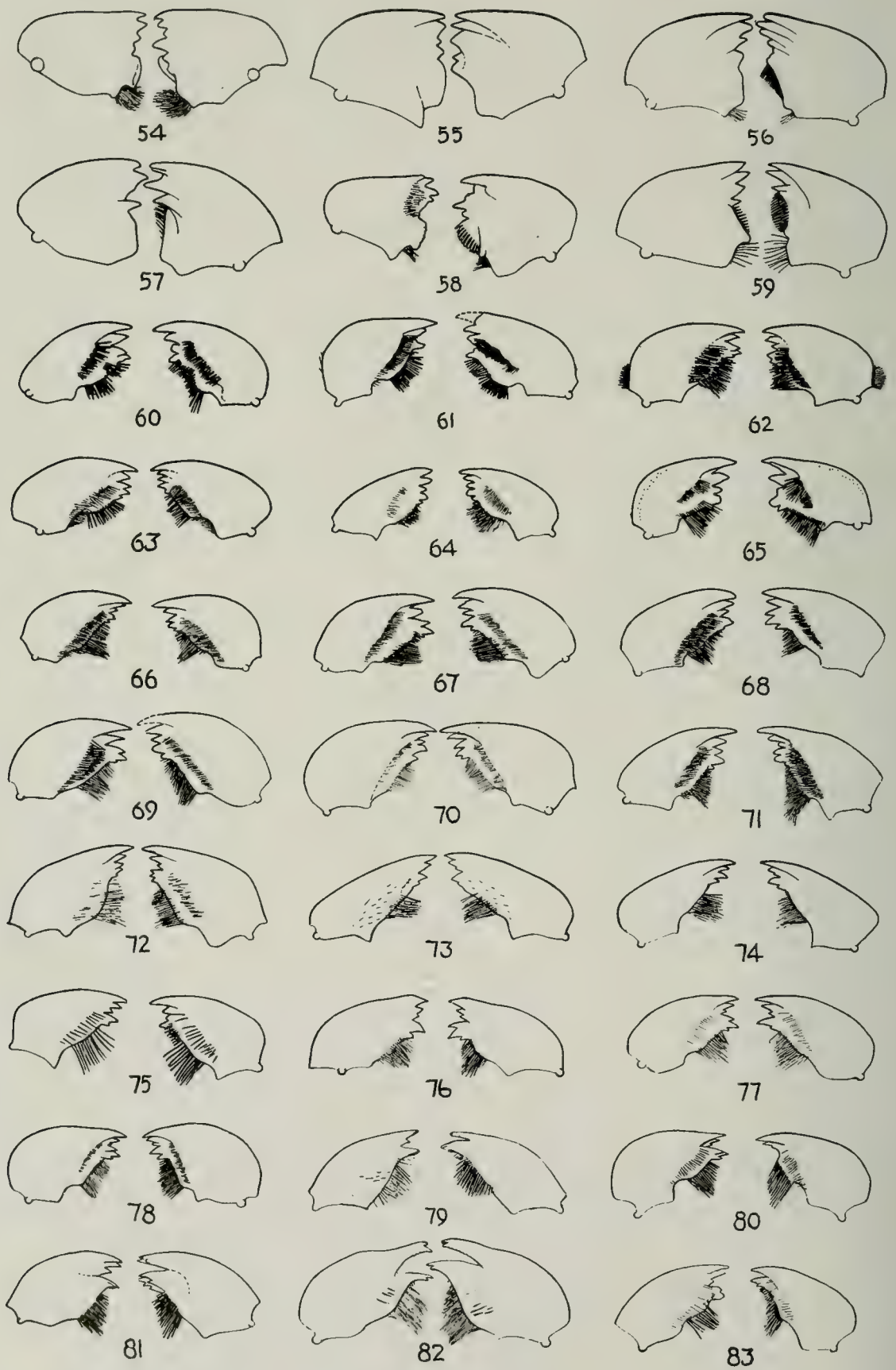


PLATE II

PLATE II

VENTRAL VIEW OF MANDIBLES OF NYMPH

- Fig. 54.—*Pteronarcys nobilis*, male.
Fig. 55.—*Taeniopteryx nivalis*, female.
Fig. 56.—*Strophopteryx fasciata*, female.
Fig. 57.—*Allocaonia vivipara*, female.
Fig. 58.—*Nemoura venosa*, female.
Fig. 59.—*Leuctra claasseni*, female.
Fig. 60.—*Atoperla ephyre*, female.
Fig. 61.—*Perlinella drymo*, female.
Fig. 62.—*Neoperla clymene*, female.
Fig. 63.—*Perlesta placida*, female.
Fig. 64.—*Acroneuria abnormis*, female.
Fig. 65.—*Acroneuria arida*, female.
Fig. 66.—*Acroneuria internata*, female.
Fig. 67.—*Acroneuria ruralis*, female.
Fig. 68.—*Acroneuria* sp. a, female.
Fig. 69.—*Acroneuria* sp. b, female.
Fig. 70.—*Neophasganophora capitata*, female.
Fig. 71.—*Togoperla media*, male.
Fig. 72.—*Togoperla* sp. a, female.
Fig. 73.—*Hydroperla crosbyi*, male.
Fig. 74.—*Hydroperla harti*, male.
Fig. 75.—*Chloroperla cydippe*, female.
Fig. 76.—*Isoperla bilineata*, female.
Fig. 77.—*Isoperla clio*, female.
Fig. 78.—*Isoperla confusa*, female.
Fig. 79.—*Isoperla decepta*, female.
Fig. 80.—*Isoperla duplicata*, female.
Fig. 81.—*Isoperla minuta*, female.
Fig. 82.—*Isoperla mohri*, female.
Fig. 83.—*Isoperla richardsoni*, male.



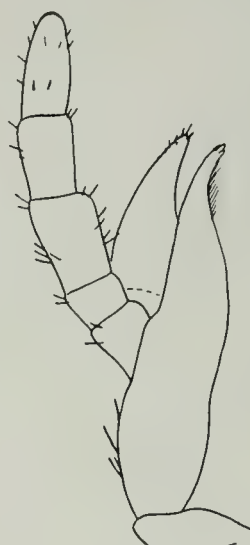
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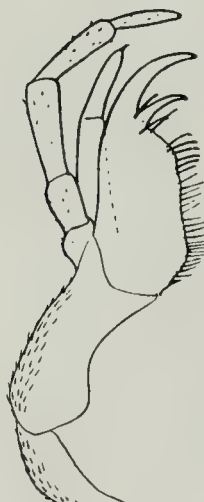
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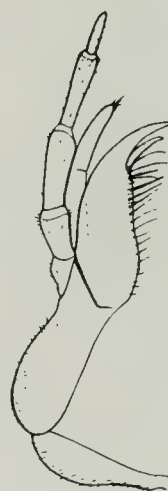
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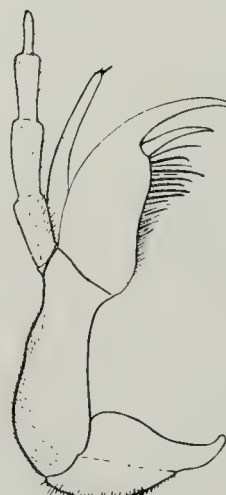
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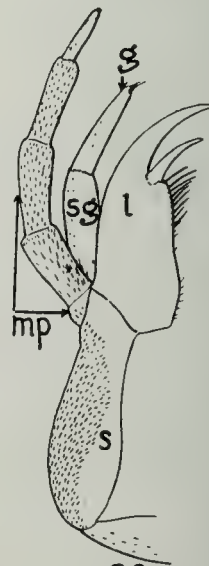
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PLATE III

PLATE III

VENTRAL VIEW OF RIGHT MAXILLA OF NYMPH

- Fig. 84.—*Pteronarcys nobilis*, male.
Fig. 85.—*Taeniopteryx nivalis*, female.
Fig. 86.—*Strophopteryx fasciata*, female.
Fig. 87.—*Allocapnia vivipara*, female.
Fig. 88.—*Leuctra claasseni*, female.
Fig. 89.—*Nemoura venosa*, female.
Fig. 90.—*Atoperla ephyre*, female.
Fig. 91.—*Perlinella drymo*, female.
Fig. 92.—*Neoperla clymene*, female.
Fig. 93.—*Perlesta placida*, female.
Fig. 94.—*Acroneuria abnormis*, female.
Fig. 95.—*Acroneuria arida*, female.
Fig. 96.—*Acroneuria internata*, female.
Fig. 97.—*Acroneuria ruralis*, female.
Fig. 98.—*Acroneuria sp. a.*, female.

ABBREVIATIONS

- g—galea
l—lacinia
mp—maxillary palpus
s—stipes
sg—subgalea

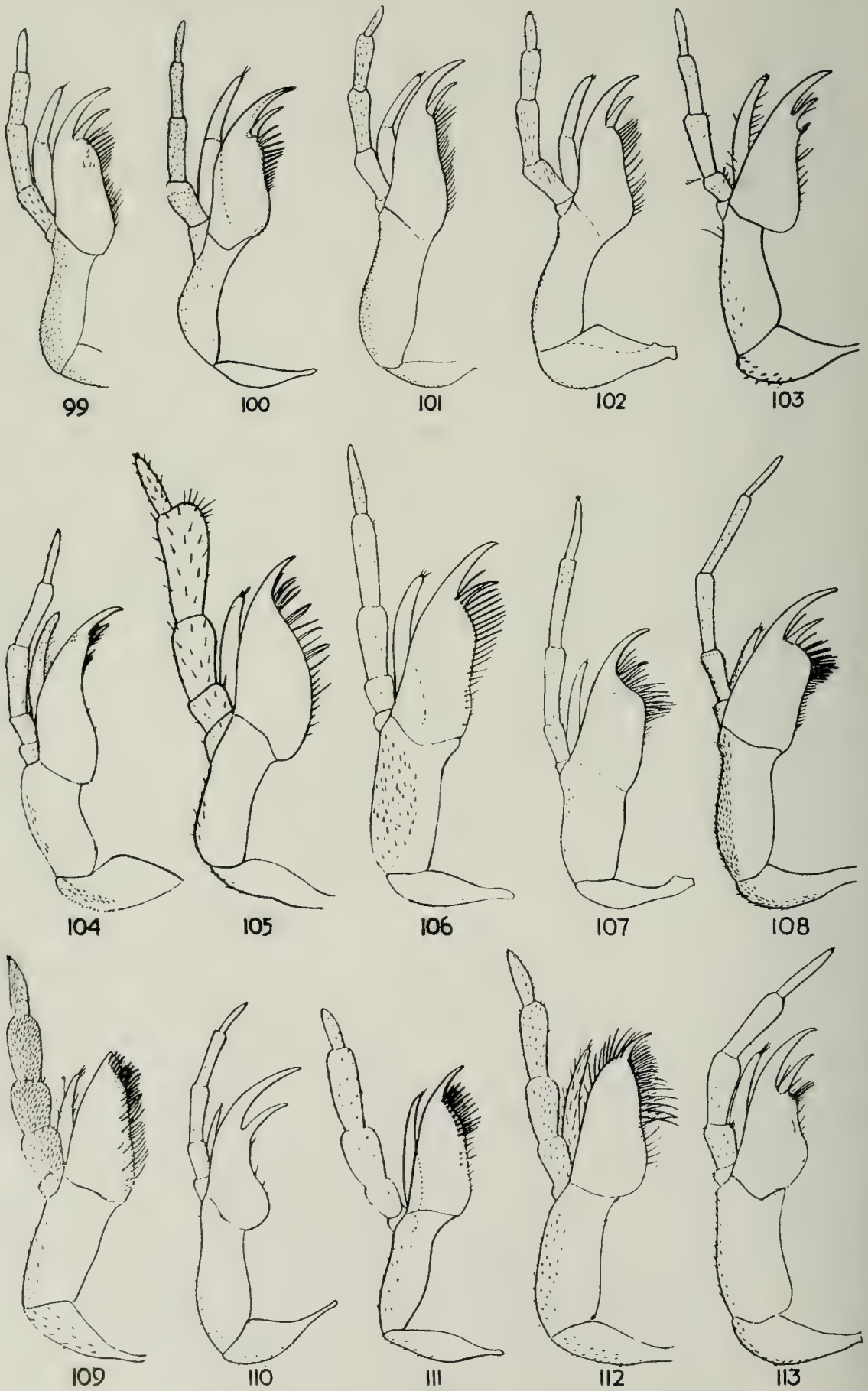


PLATE IV

PLATE IV

VENTRAL VIEW OF RIGHT MAXILLA OF NYMPH—CONT'D

- Fig. 99.—*Acroneuria sp. b.*, female.
Fig. 100.—*Neophasganophora capitata*, female.
Fig. 101.—*Togoperla media*, male.
Fig. 102.—*Togoperla sp. a.*, female.
Fig. 103.—*Hydroperla crosbyi*, male.
Fig. 104.—*Hydroperla harti*, male.
Fig. 105.—*Chloroperla cydippe*, female.
Fig. 106.—*Isoperla bilineata*, female.
Fig. 107.—*Isoperla clio*, female.
Fig. 108.—*Isoperla confusa*, female.
Fig. 109.—*Isoperla decepta*, female.
Fig. 110.—*Isoperla duplicata*, female.
Fig. 111.—*Isoperla minuta*, female.
Fig. 112.—*Isoperla mohri*, female.
Fig. 113.—*Isoperla richardsoni*, male.

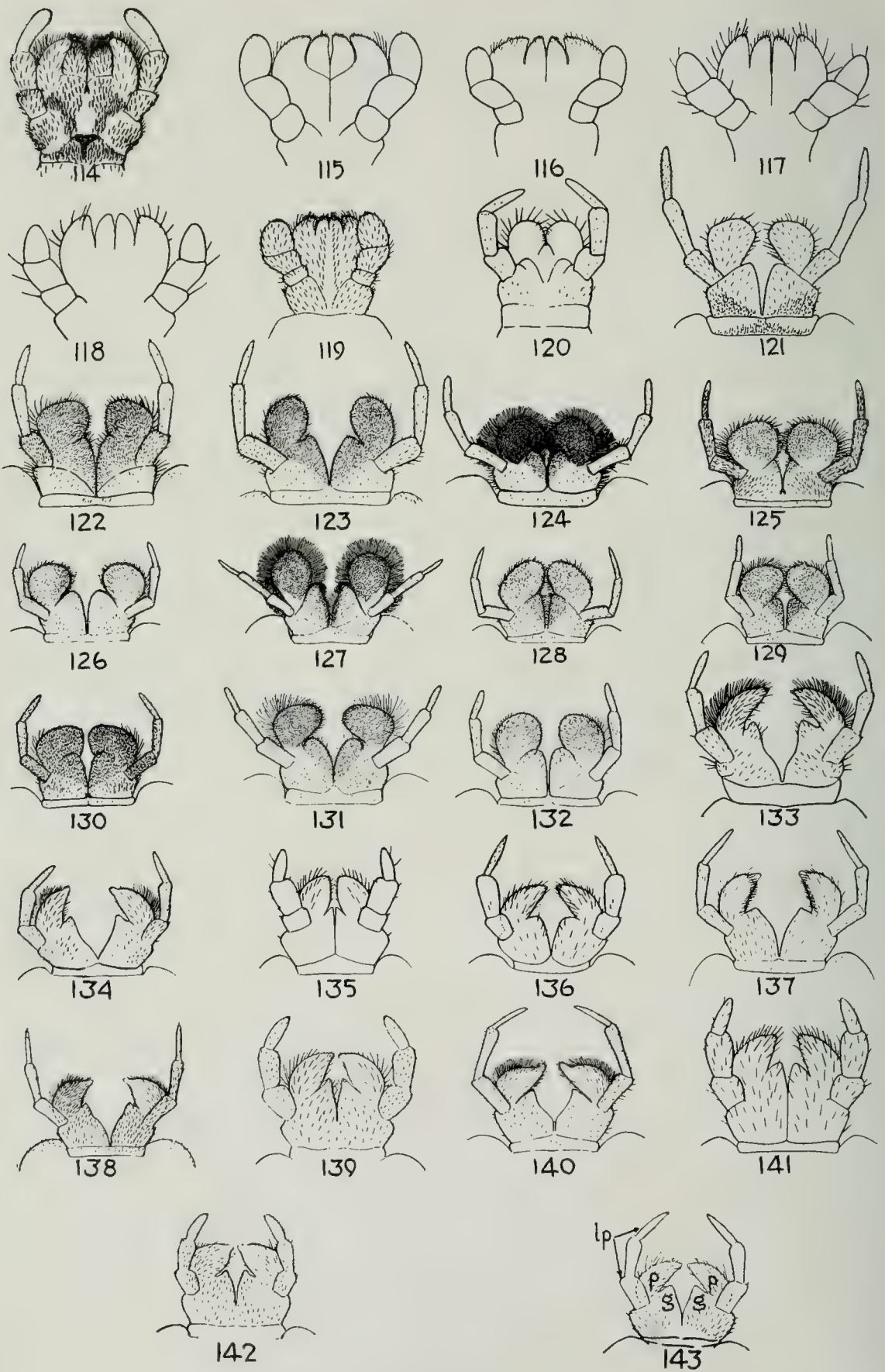


PLATE V

PLATE V

VENTRAL VIEW OF LABIUM OF NYMPH

- Fig. 114.—*Pteronarcys nobilis*, male.
 Fig. 115.—*Taeniopteryx nivalis*, female.
 Fig. 116.—*Strophopteryx fasciata*, female.
 Fig. 117.—*Allocaonia vivipara*, female.
 Fig. 118.—*Leuctra claasseni*, female.
 Fig. 119.—*Nemoura venosa*, female.
 Fig. 120.—*Atoperla ephyre*, female.
 Fig. 121.—*Perlinella drymo*, female.
 Fig. 122.—*Neoperla clymene*, female.
 Fig. 123.—*Perlesta placida*, female.
 Fig. 124.—*Acroneuria abnormis*, female.
 Fig. 125.—*Acroneuria arida*, female.
 Fig. 126.—*Acroneuria internata*, female.
 Fig. 127.—*Acroneuria ruralis*, female.
 Fig. 128.—*Acroneuria* sp. a., female.
 Fig. 129.—*Acroneuria* sp. b., female.
 Fig. 130.—*Neophasganophora capitata*, female.
 Fig. 131.—*Togoperla media*, male.
 Fig. 132.—*Togoperla* sp. a., female.
 Fig. 133.—*Hydroperla crosbyi*, male.
 Fig. 134.—*Hydroperla harti*, female.
 Fig. 135.—*Chloroperla cydippe*, female.
 Fig. 136.—*Isoperla bilineata*, female.
 Fig. 137.—*Isoperla clio*, female.
 Fig. 138.—*Isoperla confusa*, female.
 Fig. 139.—*Isoperla decepta*, female.
 Fig. 140.—*Isoperla duplicata*, female.
 Fig. 141.—*Isoperla minuta*, female.
 Fig. 142.—*Isoperla mohri*, female.
 Fig. 143.—*Isoperla richardsoni*, male.

ABBREVIATIONS

- g—glossa
 lp—labial palpus
 p—paraglossa



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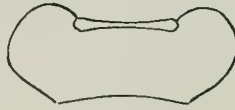
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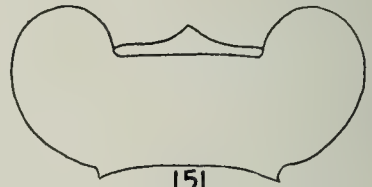
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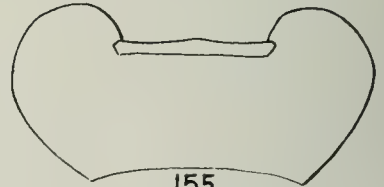
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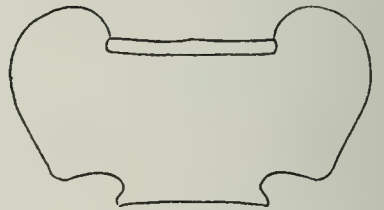
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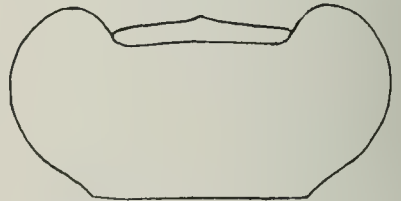
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PLATE VI

PLATE VI

VENTRAL VIEW OF MENTUM AND SUBMENTUM OF NYMPH

- Fig. 144.—*Allocaonia vivipara*, female.
Fig. 145.—*Isoperla clio*, female.
Fig. 146.—*Atoperla ephyre*, female.
Fig. 147.—*Acroneuria ruralis*, female.
Fig. 148.—*Strophopteryx fasciata*, female.
Fig. 149.—*Perlesta placida*, female.
Fig. 150.—*Neophasganophora capitata*, female.
Fig. 151.—*Acroneuria abnormis*, female.
Fig. 152.—*Nemoura venosa*, female.
Fig. 153.—*Leuctra claasseni*, female.
Fig. 154.—*Perlinella drymo*, female.
Fig. 155.—*Acroneuria arida*, female.
Fig. 156.—*Taeniopteryx nivalis*, female.
Fig. 157.—*Togoperla* sp. a., female.
Fig. 158.—*Isoperla minuta*, female.
Fig. 159.—*Acroneuria internata*, female.
Fig. 160.—*Pteronarcys nobilis*, female.
Fig. 161.—*Isoperla bilineata*, female.
Fig. 162.—*Isoperla mohri*, female.
Fig. 163.—*Isoperla decepta*, female.
Fig. 164.—*Neoperla clymeme*, female.
Fig. 165.—*Isoperla confusa*, female.
Fig. 166.—*Acroneuria* sp. a., female.
Fig. 167.—*Hydroperla harti*, male.
Fig. 168.—*Hydroperla crosbyi*, female.
Fig. 169.—*Acroneuria* sp. b, female.

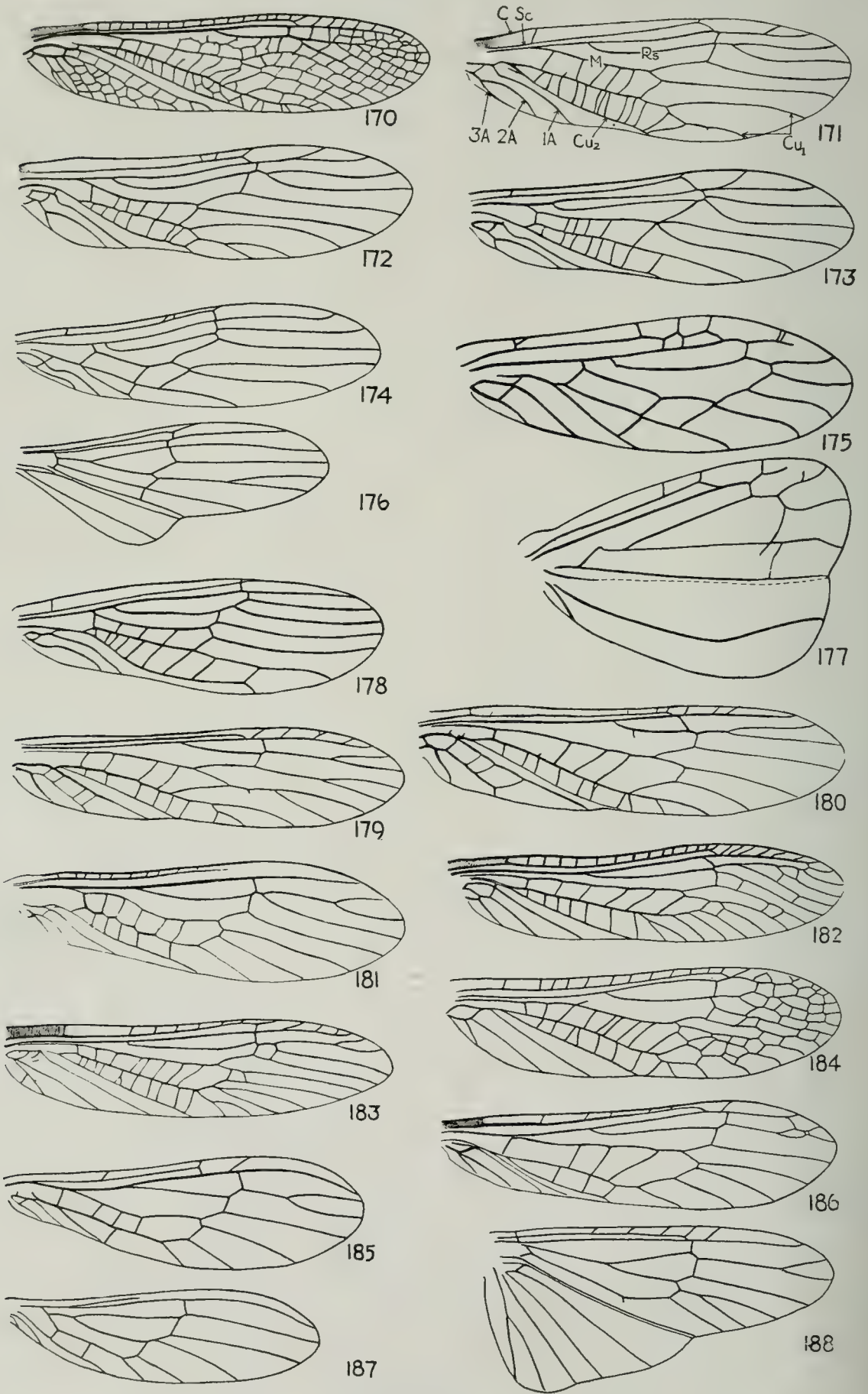


PLATE VII

PLATE VII

DORSAL VIEW OF RIGHT WINGS

- Fig. 170.—*Pteronarcys nobilis*, female. Forewing.
 Fig. 171.—*Taeniopteryx nivalis*, female. Forewing.
 Fig. 172.—*Strophopteryx fasciata*, female. Forewing.
 Fig. 173.—*Nemoura venosa*, female. Forewing.
 Fig. 174.—*Capnia* sp., female. Forewing.
 Fig. 175.—*Allocaupnia mystica*, female. Forewing.
 Fig. 176.—*Capnia* sp., female. Hind wing.
 Fig. 177.—*Allocaupnia mystica*, female. Hind wing.
 Fig. 178.—*Leuctra claasseni*, female. Forewing.
 Fig. 179.—*Atoperla ephyre*, female. Forewing.
 Fig. 180.—*Perlinella drymo*, female. Forewing.
 Fig. 181.—*Neoperla clymene*, female. Forewing.
 Fig. 182.—*Acroneuria abnormis*, female. Forewing.
 Fig. 183.—*Hydroperla crosbyi*, female. Forewing.
 Fig. 184.—*Perlodes dolobrata*, female. Forewing. (After Needham and Claassen)
 Fig. 185.—*Chloroperla cydippe*, female. Forewing.
 Fig. 186.—*Isoperla bilineata*, female. Forewing.
 Fig. 187.—*Chloroperla cydippe*, female. Hind wing.
 Fig. 188.—*Isoperla bilineata*, female. Hind wing.

ABBREVIATIONS

- C—costa
 Sc—subcosta
 Rs—radial sector
 M—media
 Cu₁—cubitus 1
 Cu₂—cubitus 2
 1A—first anal
 2A—second anal
 3A—third anal

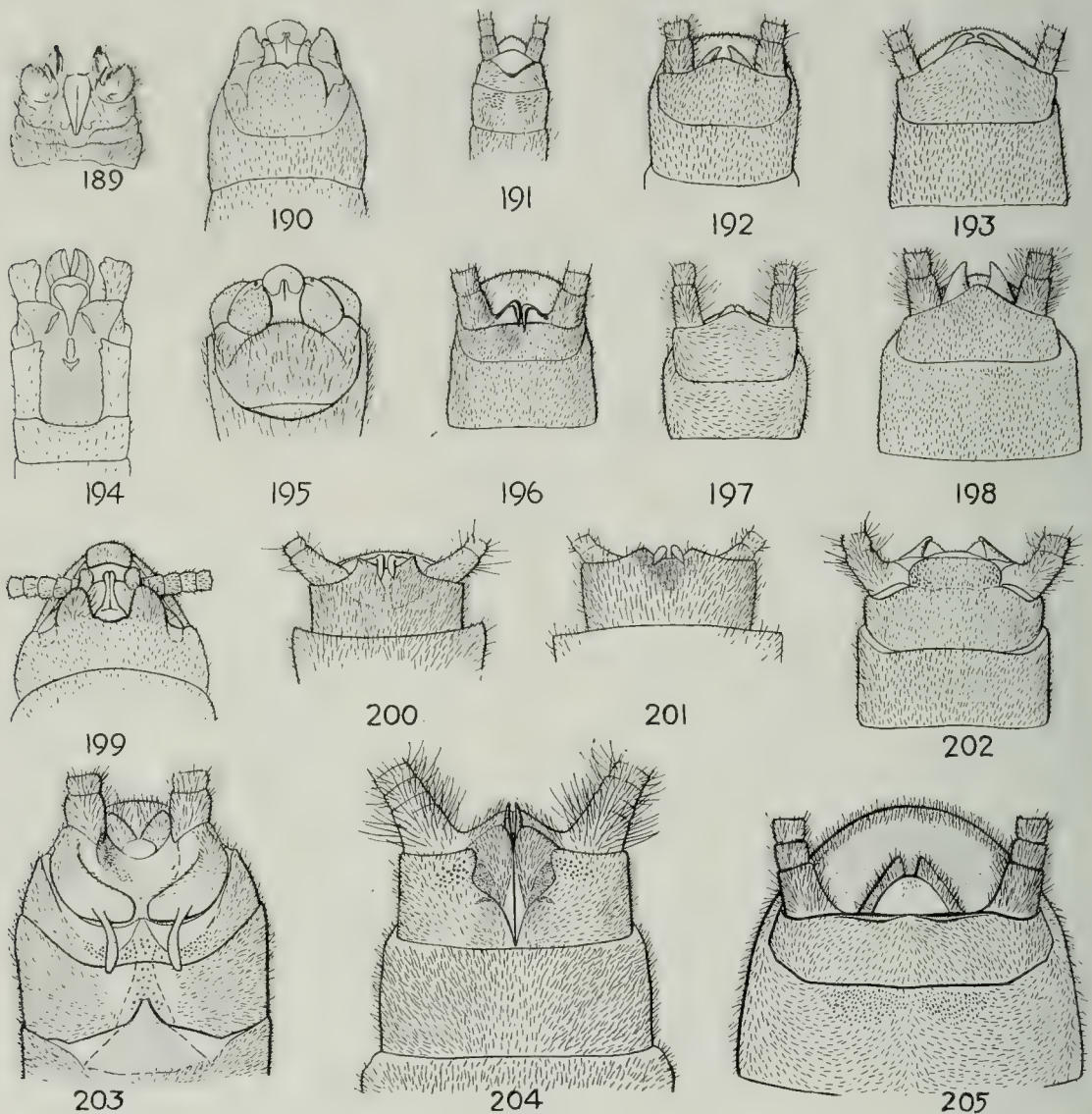
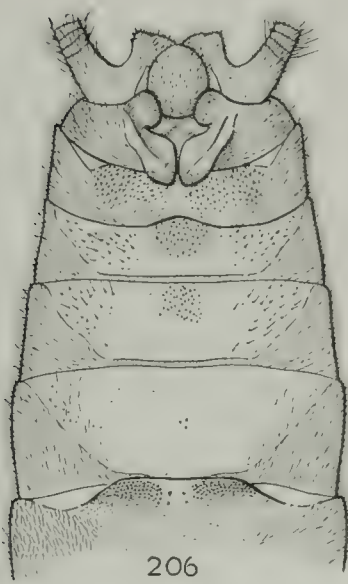


PLATE VIII

DORSAL VIEW OF ADULT MALE TERMINAL ABDOMINAL SEGMENTS

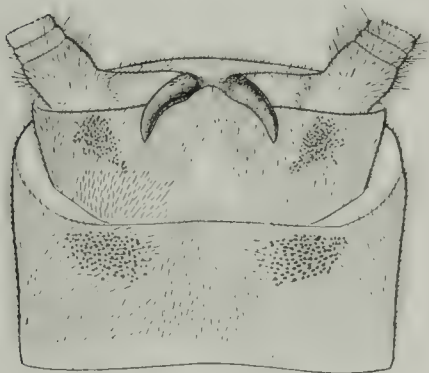
- Fig. 189.—*Nemoura venosa*.
 Fig. 190.—*Taeniopteryx parvula*.
 Fig. 191.—*Chloroperla cydippe*.
 Fig. 192.—*Isoperla decepta*.
 Fig. 193.—*Isoperla mohri*.
 Fig. 194.—*Leuctra claasseni*.
 Fig. 195.—*Taeniopteryx nivalis*.
 Fig. 196.—*Isoperla minuta*.
 Fig. 197.—*Isoperla richardsoni*.
 Fig. 198.—*Isoperla bilineata*.
 Fig. 199.—*Strophopteryx fasciata*.
 Fig. 200.—*Atoperla ephyre*.
 Fig. 201.—*Perlinella drymo*.
 Fig. 202.—*Perlesta placida*.
 Fig. 203.—*Neoperla clymene*.
 Fig. 204.—*Isoperla duplicata*.
 Fig. 205.—*Isoperla confusa*.



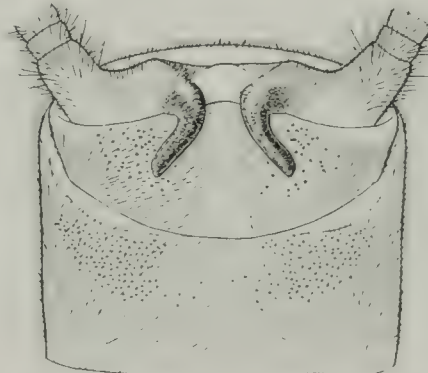
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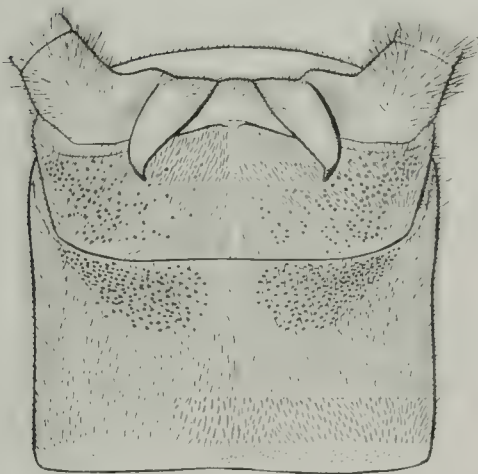
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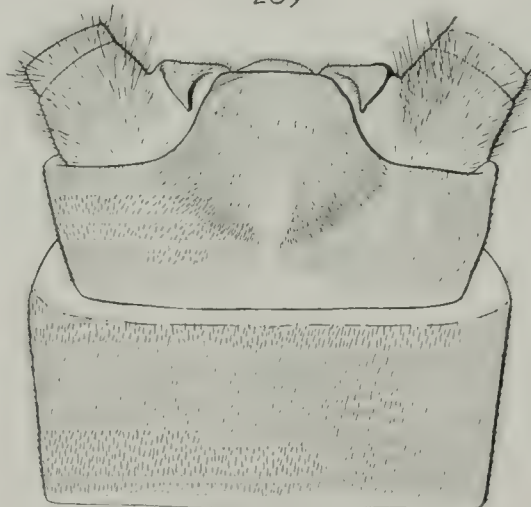
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209



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211

PLATE IX

DORSAL VIEW OF ADULT MALE TERMINAL ABDOMINAL
SEGMENTS—CONT'DFig. 206.—*Togoperla media*.Fig. 207.—*Neophasganophora capitata*.Fig. 208.—*Acroneuria arida*.Fig. 209.—*Acroneuria internata*.Fig. 210.—*Acroneuria abnormis*.Fig. 211.—*Acroneuria ruralis*.

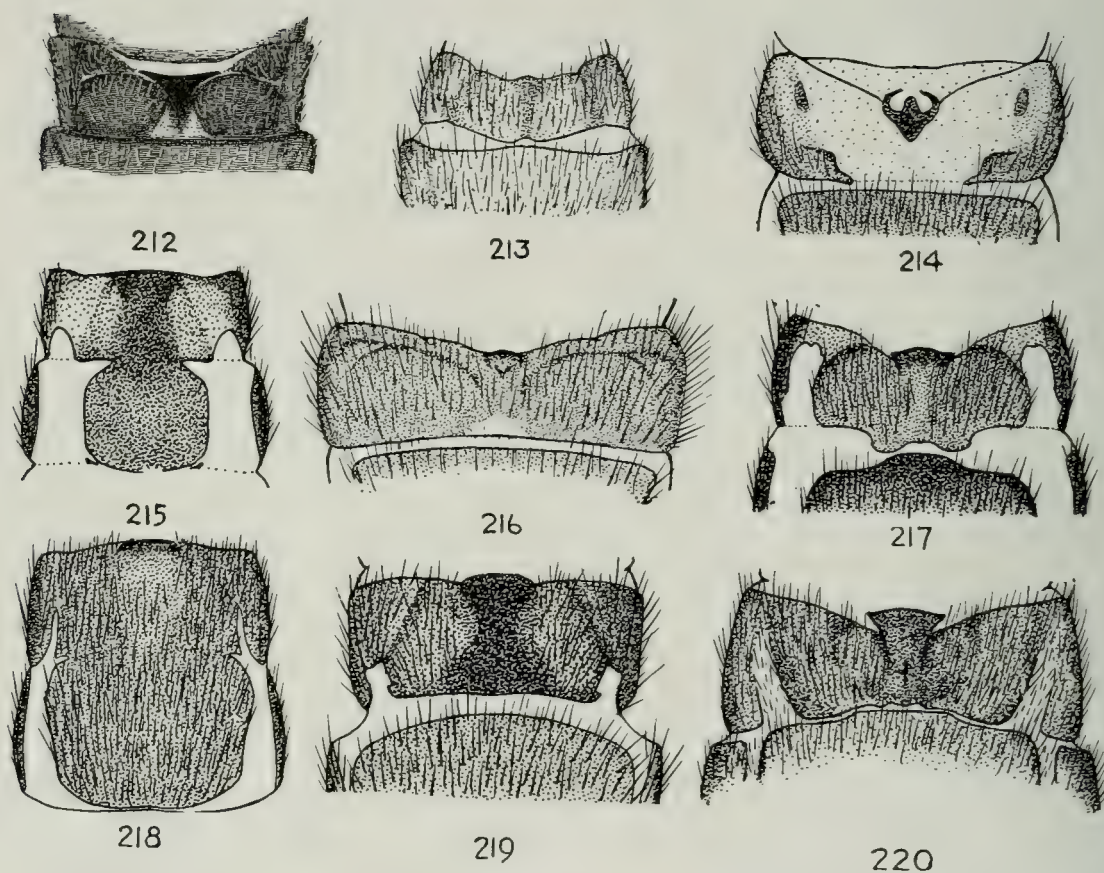


PLATE X

SEVENTH AND EIGHTH ABDOMINAL STERNITES OF ADULT FEMALE,
SHOWING SUBGENITAL PLATE

- Fig. 212.—*Allocapnia illinoensis*.
 Fig. 213.—*Allocapnia recta*.
 Fig. 214.—*Taeniopteryx parvula*.
 Fig. 215.—*Allocapnia pygmaea*.
 Fig. 216.—*Taeniopteryx nivalis*.
 Fig. 217.—*Allocapnia forbesi*.
 Fig. 218.—*Allocapnia vivipara*.
 Fig. 219.—*Allocapnia mystica*.
 Fig. 220.—*Allocapnia granulata*.

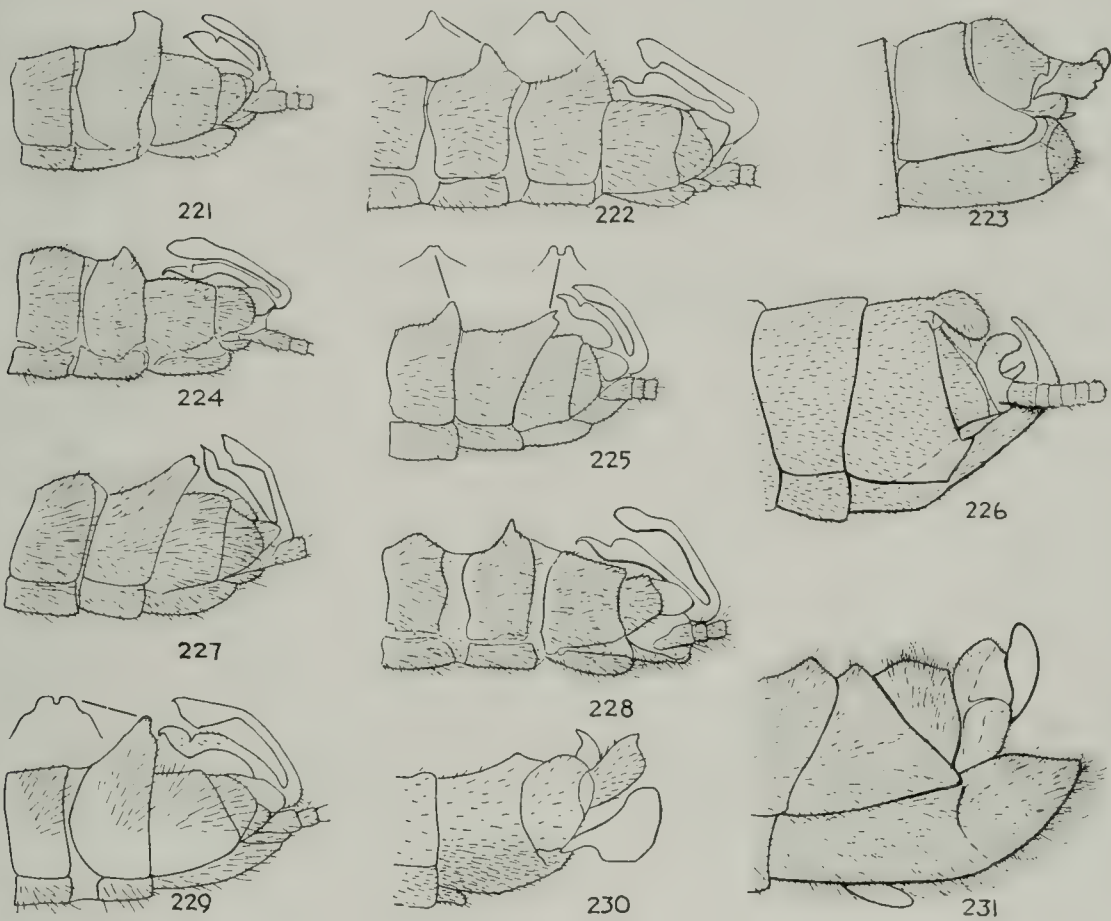


PLATE XI

LATERAL VIEW OF MALE TERMINAL ABDOMINAL SEGMENTS
AND GENITALIA

- Fig. 221.—*Allocapnia recta*.
 Fig. 222.—*Allocapnia forbesi*.
 Fig. 223.—*Taeniopteryx parvula*.
 Fig. 224.—*Allocapnia pygmaea*.
 Fig. 225.—*Allocapnia illinoensis*.
 Fig. 226.—*Strophopteryx fasciata*.
 Fig. 227.—*Allocapnia granulata*.
 Fig. 228.—*Allocapnia vivipara*.
 Fig. 229.—*Allocapnia mystica*.
 Fig. 230.—*Leuctra claasseni*.
 Fig. 231.—*Taeniopteryx nivalis*.

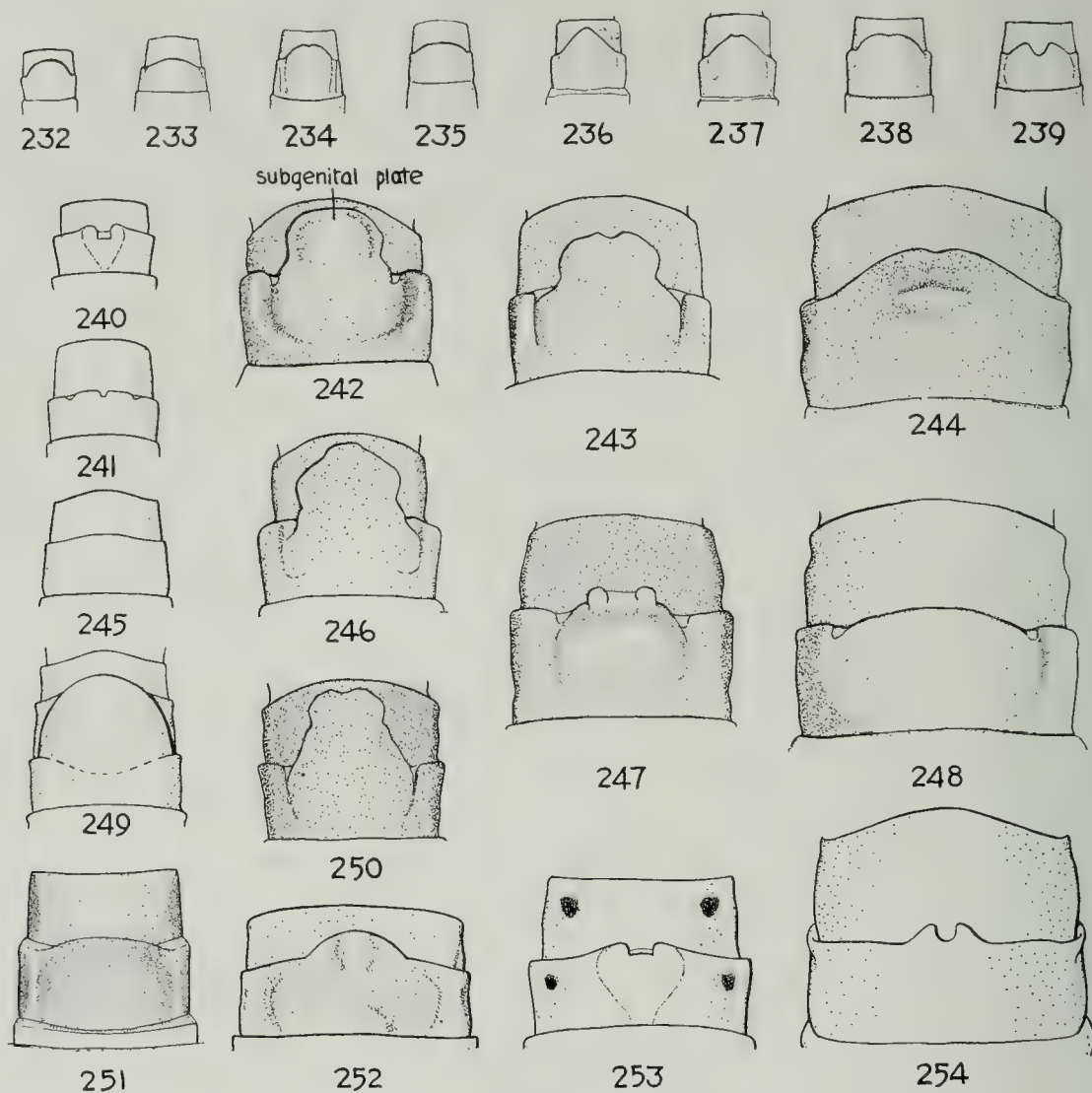


PLATE XII

FEMALE ABDOMINAL STERNITES, SHOWING SUBGENITAL PLATE

- Fig. 232.—*Chloroperla cydippe*.
 Fig. 233.—*Isoperla decepta*.
 Fig. 234.—*Isoperla minuta*.
 Fig. 235.—*Isoperla richardsoni*.
 Fig. 236.—*Isoperla bilineata*.
 Fig. 237.—*Isoperla bilineata*.
 Fig. 238.—*Isoperla mohri*.
 Fig. 239.—*Isoperla conspicua*.
 Fig. 240.—*Atoperla ephyre*.
 Fig. 241.—*Perlesta placida*.
 Fig. 242.—*Acroneuria arida*.
 Fig. 243.—*Acroneuria arida*.

- Fig. 244.—*Acroneuria ruralis*.
 Fig. 245.—*Neoperla clymene*.
 Fig. 246.—*Acroneuria arida*.
 Fig. 247.—*Acroneuria internata*.
 Fig. 248.—*Acroneuria abnormis*.
 Fig. 249.—*Isoperla duplicata*.
 Fig. 250.—*Acroneuria arida*.
 Fig. 251.—*Isoperla confusa*.
 Fig. 252.—*Neophasganophora capitata*.
 Fig. 253.—*Perlinella drymo*.
 Fig. 254.—*Togoperla media*.

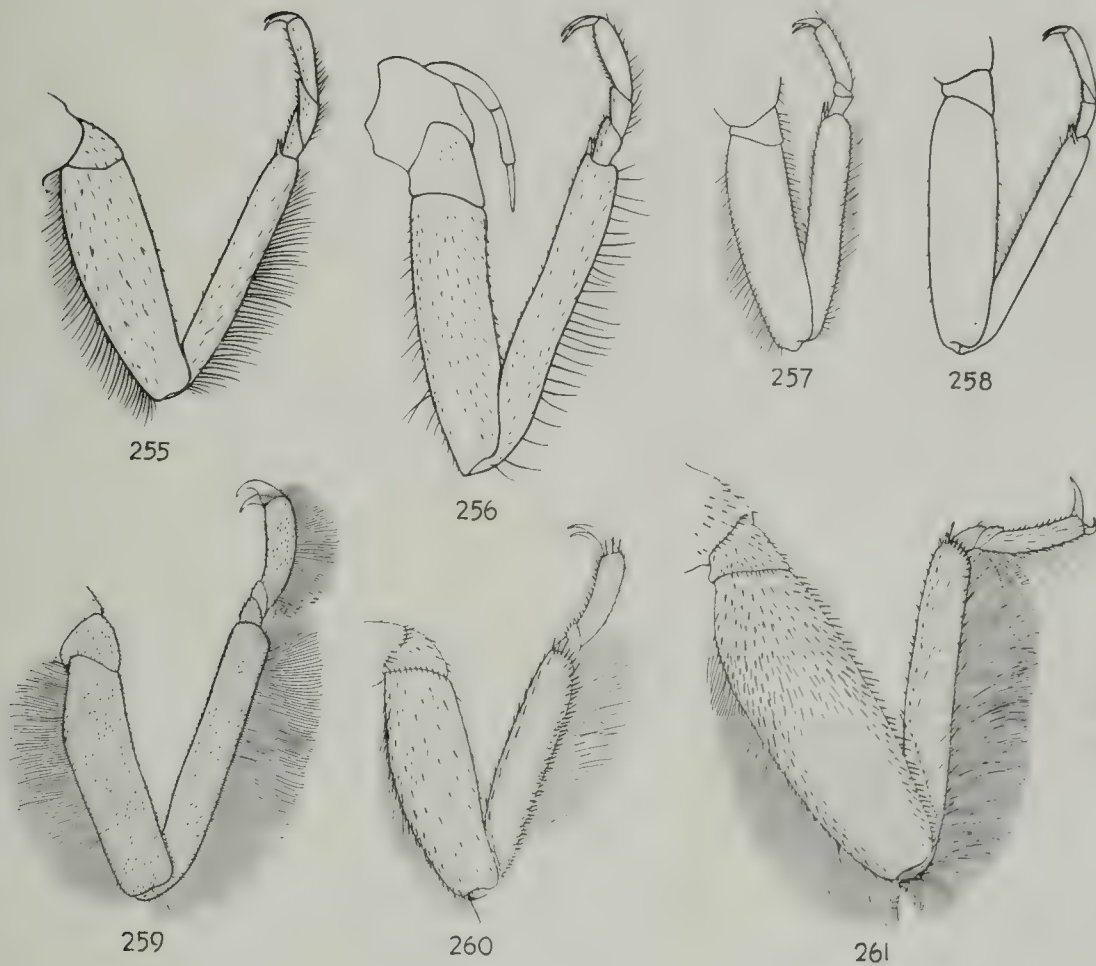


PLATE XIII

DORSAL VIEW OF RIGHT HIND LEG OF NYMPH

- Fig. 255.—*Strophopteryx fasciata*, male.
 Fig. 256.—*Taeniopteryx nivalis*, male.
 Fig. 257.—*Allocaenia vivipara*, male.
 Fig. 258.—*Leuctra claasseni*, male.
 Fig. 259.—*Pteronarcys nobilis*, male.
 Fig. 260.—*Isoperla bilineata*, male.
 Fig. 261.—*Neoperla clymene*, male.

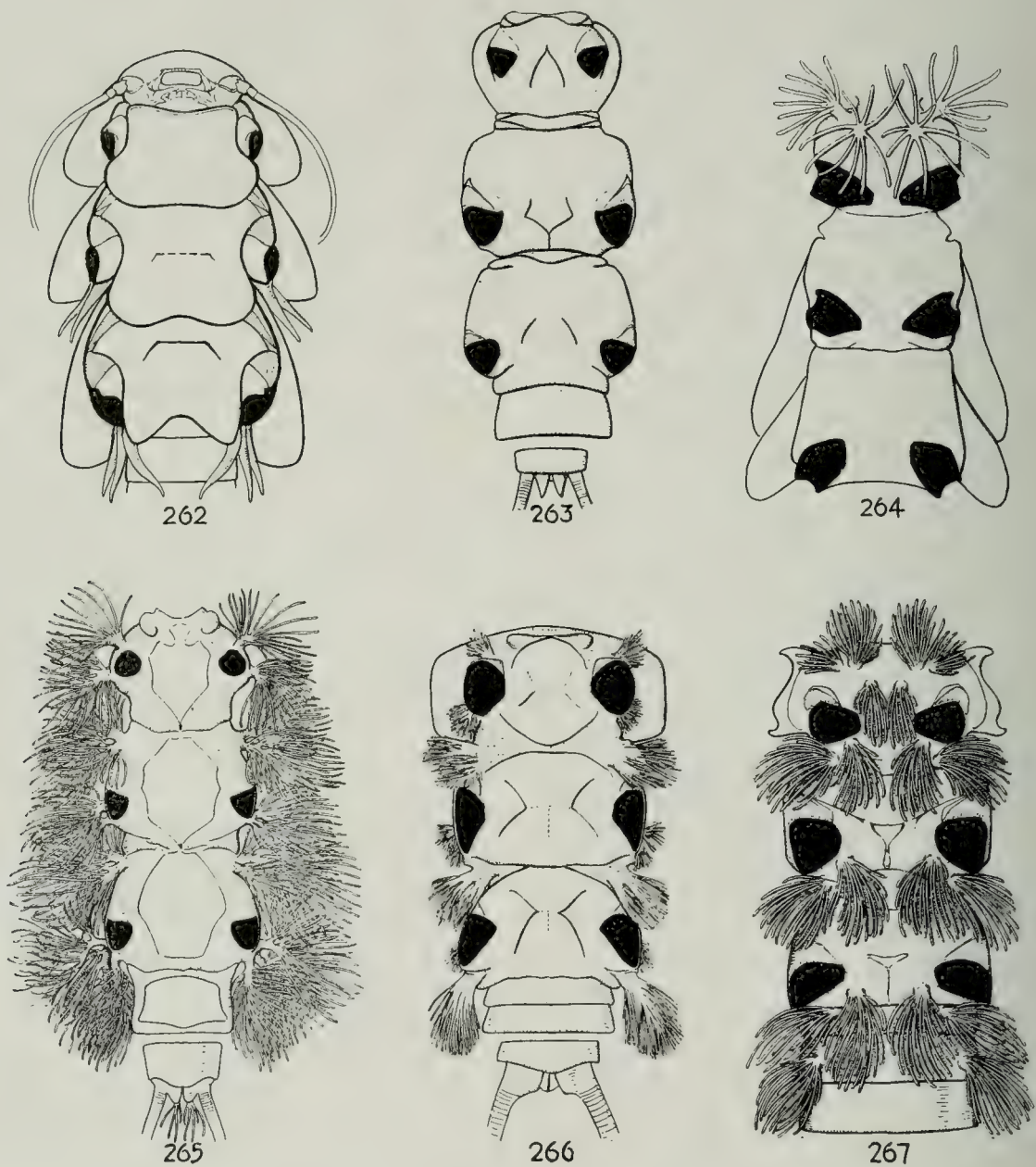


PLATE XIV

VENTRAL VIEW OF THORAX AND SEVERAL ABDOMINAL SEGMENTS OF
 NYMPHS, SHOWING ARRANGEMENT AND TYPE OF GILLS
 (The black spots indicate leg attachments)

- Fig. 262.—*Peltoperla arcuata*, female. Note overlapping shieldlike sternites.
 Fig. 263.—*Isoperla bilineata*, female. Note absence of gills.
 Fig. 264.—*Nemoura venosa*, female.
 Fig. 265.—*Perlinella drymo*, female.
 Fig. 266.—*Acroneuria internata*, female.
 Fig. 267.—*Pteronarcys nobilis*, female.

KEY TO FAMILIES
OF THE PLECOPTERA OF NORTH AMERICA

Adults

1. Anal area of forewings with two or more rows of crossveins, fig. 170.³ Basal abdominal sternites with remnants of nymphal gills. **PTERONARCIDAE**, p. 334
 Anal area of forewings entirely without crossveins, fig. 171, or with but one row, fig. 179. Basal abdominal segments without remnants of nymphal gills.....2
2. Cerci very short, one to eight segmented, figs. 223, 226.....3
 Cerci long, always with more than 10 segments, fig. 1.....5
3. Second tarsal segment about as long as other tarsal segments, figs. 255, 256.....**TAENIOPTERYGIDAE**, p. 339
 Second tarsal segment much shorter than the other tarsal segments, fig. 260...4
4. Apical marginal space beyond tip of subcosta with an oblique crossvein, fig. 173. Species often with gill remnants in cervical region, known Illinois species always.....**NEMOURIDAE**, p. 349
 Apical marginal space beyond tip of subcosta without an oblique crossvein, fig. 178. No gill remnants visible.....**LEUCTRIDAE**, p. 352
5. Forewing with a series of median and cubital crossveins, figs. 181, 182. First tarsal segment short, much shorter than third tarsal segment. Remnants of nymphal gills present or absent, fig. 2.....6
 Forewing without a series of median and cubital crossveins or at most with one or two median and one cubital crossvein, figs. 174, 176. First tarsal segment long, about as long as third segment. Remnants of nymphal gills entirely lacking.....**CAPNIIDAE**, p. 355
6. Cerci not longer than greatest width of prothorax. Prothorax much wider than head. (Not known from Illinois).....**PELTOPERLIDAE**
 Cerci much longer than greatest width of prothorax. Prothorax about as wide as head.....7
7. Remnants of nymphal gills on sides or venter of thorax, in position corresponding to location of gills in nymphs, fig. 3a.....**PERLIDAE**, p. 372
 No remnants of nymphal gills on sides or venter of thorax.....8
8. Remnant of finger-like nymphal gills located near each side of outer basal corner of submentum, figs. 167, 168. Males with tenth tergite deeply cleft. Medium sized species with a body length usually more than 13 mm. Species dominantly dark. Some species (Perlodes—not known from Illinois) with network of crossveins between branches of radius in apical portion of forewing, fig. 184.....**PERLODIDAE**, p. 416
 No remnant of finger-like nymphal gills located near each side of outer basal corner of submentum. Males without tenth tergite cleft, fig. 196, except for *Isoperla duplicata*, fig. 204, which is easily recognized by lobes on median posterior margin of both seventh and eighth abdominal sternites, fig. 341. Small to medium sized species with a body length usually much less than 13 mm. Species ranging from dominantly yellow or whitish green to dark. All species without network of crossveins between branches of radius in apical portion of forewing, figs. 185, 187...**CHLOROPERLIDAE**, p. 427

³ Figs. 28-267 appear in Plates I-XIV immediately preceding this key. Figs. 268-ff. run with the species they illustrate, following this key.

PLECOPTERA—KEY TO FAMILIES—CONT'D

Nymphs

1. Gills present on some of the ventral basal abdominal segments, fig. 267..
.....**PTERONARCIDAE**, p. 334
Gills absent on all ventral abdominal segments.....2
2. Venter of thorax covered with large, overlapping, shieldlike plates, fig. 262.
(Not known from Illinois).....**PELTOPERLIDAE**
Venter of thorax without distinct, large, overlapping, shieldlike plates, fig. 266..3
3. Labium with paraglossae and glossae extending forward about the same distance and side by side in the same horizontal plane, figs. 115-119.....4
Labium with paraglossae extending forward much farther than the glossae, the latter deeply inset below and between the paraglossae so as to appear almost as basal segments of them, figs. 120-143.....7
4. Second tarsal segment, figs. 255, 256, approximately as long or longer than the first segment.....**TAENIOPTERYGIDAE**, p. 339
Second tarsal segment, figs. 257, 258, shorter than the first.....5
5. Small and robust nymphs, fig. 281; hairy; hind wing pads extending considerably outward from the body at an angle. Gills present or absent, when present with branched gills, fig. 264, in ventral cervical region (known Illinois species) or with single filamentous gills near bases of legs.....
.....**NEMOURIDAE**, p. 349
Small and slender nymphs, fig. 298; hairs few, fine or lacking; hind wing pads lying about parallel to longitudinal axis of body. No branched cervical gills nor filamentous gills near bases of legs.....6
6. Lateral margins of abdominal segments somewhat rounded, segments widest at posterior margin and narrower towards base, fig. 298. Wing pads, fig. 298, with one exception, fig. 297, present in half grown or full grown nymphs; hind wing pad with anal lobe or area extending far beyond middle of wing pad. Last abdominal segment with a conical projection in male, fig. 297. Anal gills never present.....**CAPNIIDAE**, p. 355
Lateral margins of abdominal segments almost straight, abdomen appearing cylindrical, fig. 283. Wing pads, fig. 283, always present in half grown to full grown nymphs; hind wing pad with anal lobe or area small and not extending much beyond middle of wing pad, fig. 283. Last abdominal segment without conical projection in either sex, fig. 283. Anal gills present at least in some species. (Illinois species with anal gills, fig. 284, but gills are easily broken off in preserved specimens and so likely not to be observed).
.....**LEUCTRIDAE**, p. 352
7. With a small membranous finger-like gill located near each side of outer basal angle of submentum, figs. 167, 168.....**PERLODIDAE**, p. 416
Without such gills on submentum, fig. 161.....8
8. Branched gills always present on sides of thorax near bases of legs and sometimes at apex of abdomen.....**PERLIDAE**, p. 372
Gills of all kinds entirely lacking.....**CHLOROPERLIDAE**, p. 427

PTERONARCIDAE

This family consists of two North American genera, *Pteronarcys* and *Pteronarcella*, only the first being known to occur in Illinois. *Pteronar-*



Fig. 268.—*Pteronarcys nobilis*, nymphal male.

cella is apparently restricted to the western part of this continent. Presence of gills on the third abdominal segment readily separates the nymphs of *Pteronarcella* from those of *Pteronarcys*. The adults differ in venational characters and in number of pairs of vestigial gills on abdominal segments.

Pteronarcys Newman

Newman (1838) p. 175. Genotype *Pteronarcys regalis* Newman
=*Pteronarcys dorsata* (Say), subsequent designation of Enderlein (1909).



Fig. 269.—TYPICAL LARGE RIVER HABITAT OF ILLINOIS STONEFLIES. The Rock river at Oregon and similar streams within or bordering the state are favored by *Acroneuria abnormis*, *A. ruralis* and *Pteronarcys nobilis*.

Pteronarcys nobilis Hagen

Figs. 19, 28, 54, 84, 114, 160, 170, 259, 267, 268⁴, 270, 271, 272, 273, 274, 275.

Pteronarcys nobilis Hagen (1861) p. 15. Original description (♂).

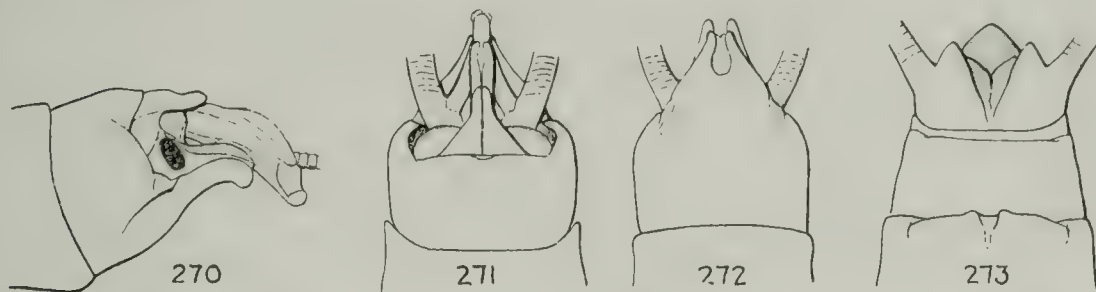
Our studies reveal only one species of this genus, *nobilis* Hagen, from Illinois. It was first recorded from our state by Walsh (1862) from Rock Island. In the "Table of Distribution by States" of Needham and Claassen (1925) two species of *Pteronarcys* are indicated without definite records for Illinois, and in the text *dorsata* (Say) is stated to be "common in small rivers of the central states." The two species thus indicated are undoubtedly *dorsata* and *nobilis*. Material in the collection of Cornell university has no actual specimens of *dorsata* from Illinois.

Adults of these gigantic stoneflies are essentially nocturnal and by day hide under bridges or other objects that offer fair protection from light. They have never been observed to feed and structure of the mouthparts indicates that they never do. Lights along watercourses prove attractive to the adults at night, and most of our specimens have been captured as a result. Interestingly enough, adults of all other Illinois genera (*Allocap-*

⁴ Figure numbers in **bold face** are drawings of the nymph, dorsal view.

nia, *Taeniopteryx*, *Strophopteryx*, *Nemoura* and *Leuctra*) whose nymphs have mouthparts of the same general type as *nobilis*, figs. 28, 84, 114, 160, are diurnal and often feed on blue-green algae growing on trees and other objects near the streams where the nymphs develop. In *Pteronarcys nobilis* the mandibles are flabby and nonfunctional whereas in the above genera these structures keep their rigidity and functional ability.

Remnants of nymphal gills in the adults of the genus *Pteronarcys* first attracted the attention of Newport (1844) and have often since then been considered rather extraordinary. The facts are however that all adults that I have studied of species having conspicuous tracheal gills in the nymphs show remnants of these gills, and apparently an adult which did not show them would be an exception to the rule.



Figs. 270-273.—TERMINAL ABDOMINAL SEGMENTS AND GENITALIA OF *Pteronarcys nobilis*. 270.—Lateral view of male. 271.—Dorsal view of male. 272.—Ventral view of male. 273.—Ventral view of female.

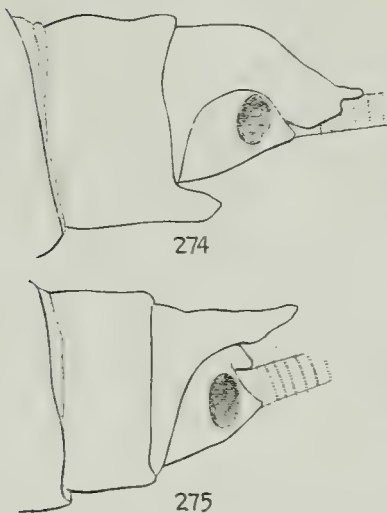
The adults begin emerging in Illinois in April and a few are still emerging during the first days of June. A female with eggs has been taken at Rock Island on June 3.

The nymphs of *nobilis* are not found in Illinois in the small creeks and brooks, which are capable of sustaining certain *Allocapnia*, *Nemoura* and *Leuctra*. Instead they are found in the medium sized rivers such as the Embarrass, fig. 13, and the largest rivers such as the Rock, fig. 269, and Mississippi. The nymphs apparently prefer some riffle in the stream where they can cling to submerged decaying objects, such as branches or trunks of trees which tend to lodge in such places, or where they can be covered with a finer debris of twigs and old leaves. Our records for the various sizes of the nymphs are indicative that it requires about two years for development from egg to adult. Examinations of stomach contents show the nymphs to be herbivorous, a type of feeding indicated by their mouthparts.

The adult terminal abdominal segments and genitalia are shown in figs. 270-273. Since the nymph has not been previously recognized, a description of its most important features follows.

Nymphal male, fig. 268.—General ground color of dorsum dark brown, with yellowish brown marking as follows: area behind epicranial arms, wing pads, median line and lateral margins of pronotum, spots on meso- and metanotum, spots on basal margins of abdominal tergites. Venter in general lighter than dorsum. Most specimens well incrustated with fine debris so that the obscure and rather indefinite color pattern is not evident.

Head with three ocelli forming a triangle, lateral ocelli about on a line with anterior margin of compound eyes and slightly farther apart than distant from median ocellus; a round impunctate spot on each side of head between lateral ocellus and base of antennae. Labrum, fig. 28, labium, fig. 114, maxilla, fig. 84, mandibles, fig. 54, and submentum, fig. 160, as illustrated.



Figs. 274-275.—LATERAL VIEW OF NYMPHAL TERMINAL ABDOMINAL SEGMENTS OF *Pteronarcys nobilis*. 274.—Male. 275.—Female. Shaded area indicates cercal attachment.

Pronotum much broader than long, posterior margin wider than anterior margin, anterior angles conspicuously and laterally produced, posterior angles produced but less so than anterior angles and slightly directed backwards. Mesonotum with wing pads rounded at tip and produced mainly backwards. Metanotum with wing pads rounded at tip and produced more laterally.

Legs with femur, tibia and tarsus fringed with long hairs, fig. 259; first and second tarsal segments about of equal length, third tarsal segment much longer than preceding two combined.

Abdominal segments transverse, except modified apical segments. Ninth sternite with posterior margin in middle area produced as a lobe, fig. 274, partially over tenth sternite, the lobe

slightly notched. Tenth tergite much produced posteriorly and downwards, fig. 274, entirely covering tenth tergite, with a small thumblike projection on dorsum near end. Cerci not as long as abdomen, composed of about 40 segments, apical segments longest and narrowest.

Gills present on venter, fig. 267, arranged in pairs anterior and posterior to legs and on first two ventral abdominal segments, pairs on prosternum anterior to forelegs arranged in a transverse row in cervical region. No anal-abdominal or coxal gills.

Mature specimens with a body length, exclusive of appendages, sometimes as much as 38 mm.

Nymphal female.—Similar to male in general color and most morphological details. Tenth abdominal tergite triangularly produced, fig. 275, and ending in a sharp projection. Eighth abdominal sternite not produced and with a slight notch in middle of posterior margin near opening of genital duct.

Mature specimens with a body length sometimes as much as 44 mm.

It appears from study of literature and specimens that the nymphs of *dorsata* and *nobilis* have been confused and that some nymphs recorded as *dorsata* are *nobilis*. When Smith (1917) wrote her treatise on the Pteronarcinae and Perlodini she stated that the nymph of *nobilis* was unknown. Through the kindness of Professor Claassen I have been permitted to study some of the nymphs determined by Smith (1917). I find that two female nymphs from "White Pigeon river, Michigan" and one from "Otter river, Portage county, Michigan" agree with reared nymphs of *nobilis*. This indicates that Smith confused the nymphs of *nobilis* and *dorsata* or that her description was based solely upon nymphs of *nobilis*.

The characters of the adults of *nobilis* and *dorsata* are such that it is evident that the nymphs will greatly resemble one another, and it is entirely possible that they cannot always be correctly separated. Smith (1917) does not state that she has actually reared *dorsata* and I have failed to locate nymphal material anywhere which has been definitely associated with adult *dorsata*. Until such material is available it will be impossible, if ever, to separate in a key the nymphs of *dorsata* and *nobilis*. The fact that in the adult females of *dorsata* the posterior margin of the eighth abdominal sternite is supposed to be straight and in *nobilis* is notched suggests that this difference may be expected to exist in the nymphal females. Certainly the female nymphs of *nobilis* show such a notch but due to lack of material I am in doubt about this character in *dorsata*. The structure of the genitalia of the male is such that no guesses can be made regarding probable differences.

Adults.—Arcola: May 7, 1927, 1♀. Charleston: Apr. 11, 1931, 2♂ reared; Apr. 17, 1931, 1♀ reared. Momence: June 4, 1932, 1♂, 1♀. Oregon: May 21—June 15, 1♂, 4♀; June 1930, 1♂. Rock Island: May 21, 1928, 2♂, 1♀; May 28, 1928, 1♂; July 7, 1929, 2♀; June 3, 1930, 6♂, 7♀; May 3, 1931, 1♂ reared; May 16, 1931, 1♂ reared; June 8, 1931, 1♂ reared; June 13, 1931, 3♀; May 19, 1934, 1♂.

Nymphs.—Charleston (Embarrass r.): Dec. 6, 1930; Mar. 22, 1931. Dixon (Rock r.): May 22, 1925. Milan (Rock r.): Sept. 19–29, 1927. Oregon (Rock r.): July 11, 1929. Rock Island (Rock r.): Apr. 2–3, 1928; May 16—June 8, 1931; Apr. 27, 1932. Rockford (Rock r.): Apr. 3, 1928. Rockton (Rock r.): July 25, 1926. Sterling—Dixon (Rock r.): July 29, 1925.

TAENIOPTERYGIDAE

As has been pointed out, the genera *Taeniopteryx* and *Strophopteryx* have not previously been set apart by American workers as constituting a separate family but have been considered Nemouridae. The family

Taeniopterygidae was first proposed by Klapalek (1909b) for European species and has since been accepted by others (Schoenemund 1928). It seems to me to require recognition in any comprehensive classification of the North American Plecoptera.

KEY TO GENERA⁵

Adults

- Coxae in both sexes with small round membranous areas, fig. 2a, on ventral surfaces (point of articulation of tracheal appendages in nymphs). Male with cerci reduced to a single globose segment, figs. 195, 223, and subgenital plate (prolongation of ninth ventral abdominal segment) with apical portion not abruptly turned upwards at a right angle, fig. 231. Female with ninth abdominal sternite without a long triangular projection.....**Taeniopteryx**, p. 340
- Coxae in both sexes without membranous areas on ventral surfaces, fig. 2b. Male with cerci with at least three filiform segments, fig. 199, and subgenital plate with apical portion turned abruptly upwards at a right angle, fig. 226. Female with ninth abdominal sternite with a long triangular projection, fig. 280.....**Strophopteryx**, p. 347

Nymphs

- Coxae without tracheal appendages, fig. 255. Ninth abdominal sternite with posterior portion conspicuously produced backwards in a V shaped projection, fig. 279, covering part of tenth segment.....**Strophopteryx**, p. 347
- Coxae with conspicuous tracheal appendages, fig. 256. Ninth abdominal sternite with posterior margin transverse; not produced backward in V shaped projection covering part of tenth segment.....**Taeniopteryx**, p. 340

Taeniopteryx Pictet

Pictet (1841) p. 345. Genotype *Nemoura nebulosa* Pictet = *Taeniopteryx nebulosa* (Pictet), original designation.

The writer has already (1929) given his reasons for considering the genus *Taeniopteryx* as used by Needham and Claassen (1925) to be a composite of several genera. At the same time this name was restricted among North American stoneflies to the species *maura* Pictet, *nivalis* (Fitch) and *parvula* Banks. Genus and species were then treated in rather exhaustive fashion, so that only modified excerpts from the previous paper have been given place here.

KEY TO SPECIES

Adults

- Male with a globular appendage, fig. 231, on ninth abdominal sternite (subgenital plate). Female with portion of eighth abdominal sternite, fig. 216, anterior to genital opening darkly sclerotized.....**nivalis**, p. 341

⁵ Keys to genera and species refer only to Illinois forms.

TAENIOPTERYX—KEY TO SPECIES—CONT'D

Male without a globular appendage, fig. 223, on ninth abdominal sternite. Female with portion of eighth abdominal sternite, fig. 214, anterior to genital opening not darkly sclerotized; at most with anterior border of genital opening dark, contrasting with membranous area.....*parvula*, p. 345

Nymphs

Males and females with a conspicuous white mid-dorsal stripe extending from head to end of abdomen, fig. 276. Apex of male abdomen, side view, with supra-anal lobe protruding considerably above apical segment; not so in female. Mature nymphal male with outline of globular appendage visible near middle of ninth sternite.....*nivalis*, p. 341

Males and females without a conspicuous white mid-dorsal stripe extending from head to end of abdomen, fig. 277. Apex of male abdomen, side view, with supra-anal lobe protruding considerably above apical segment; not so in female. Mature nymphal male without outline of appendage visible near middle of ninth sternite.....*parvula*, p. 345

Taeniopteryx nivalis (Fitch)

Figs. 2a, 55, 85, 115, 156, 171, 195, 216, 231, 256, 276.

Nemoura nivalis Fitch (1847) p. 279. Original description (♂, ♀).

Taeniopteryx nivalis Frison (1929) p. 378. Nymphal description (♂, ♀).

This is one of the two largest as well as one of the three most abundant and widely distributed species of our fall and winter fauna. Our records of both nymphs and adults show it to be a true member of this seasonal group. It has been recorded from the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New York, North Carolina and Pennsylvania, as well as from Illinois (Needham and Claassen 1925, Frison 1929). There is a strong probability that *maura* Pictet and *nivalis* (Fitch) are the same species (Frison 1929) in which case the former name would have priority.

There is one generation a year. The adults begin to emerge in Illinois about the first of January and reach their maximum abundance between February 15 and March 15. During the warmer parts of the day they may be collected in numbers on bridges, tree trunks or other objects near permanent streams.

Their food under natural conditions appears to consist of blue-green algae (*Protococcus*), so plentiful on nearly all objects near watercourses, but judging by their cannibalism in captivity they utilize any available food. Ovipositing females fly or crawl into the water, where the matrix holding the numerous eggs—1407 were counted in one such mass—dissolves and the eggs drop separately to the bottom. Proof of the correct

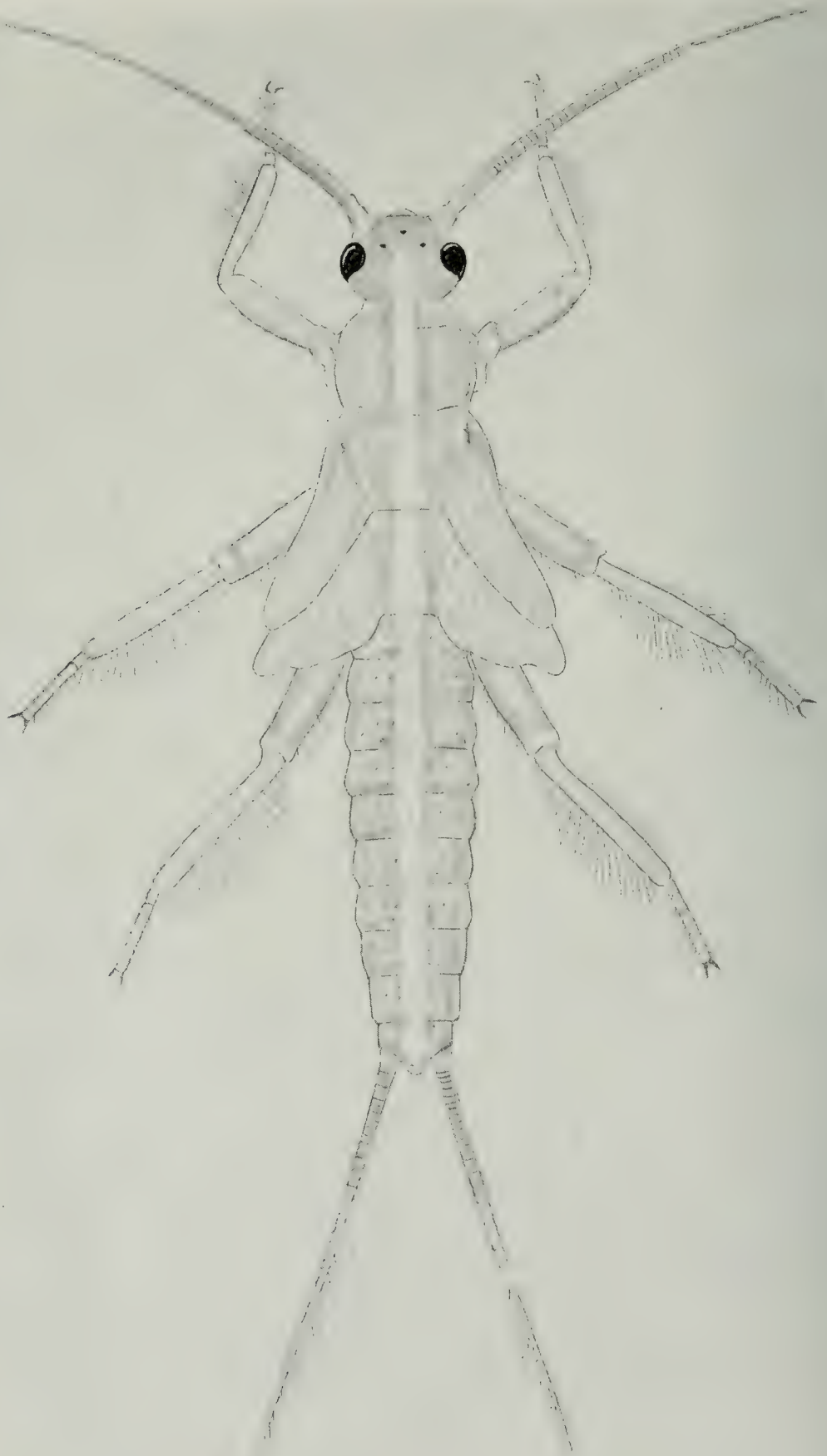


Fig. 276.—*Taeniopteryx nivalis*, NYMPHAL FEMALE.

association of males and females has been obtained by rearings and the collection of mating pairs. Features of the apical abdominal segments are shown in figs. 195, 216, 231, and the type of wing venation in fig. 171.

The nymphs are to be found in permanent streams ranging in size from the Salt Fork at Urbana to the Mississippi. Being essentially herbivorous, they live in submerged vegetable debris, particularly old leaves. During the summer months no trace of them can be found by ordinary field collecting. However, I have previously shown facts that indicate that the eggs hatch soon after being laid, but that rapid development is postponed until the temperature of the water drops noticeably, and reaches a peak sometime between November and January. The earliest that I have found the small nymphs is October 10, at Oakwood.

Detailed descriptions of male and female nymphs, based upon reared material, were published by the writer (1929). Mouthparts are shown here in figs. 55, 85, 115.

Adults.—Algonquin: 1♀. Allerton: Mar. 9, 1930, 9♀. Barstow: Apr. 2, 1928, 1♀. Big Rock: Apr. 1, 1928, 1♀. Brocton: Mar. 9, 1930, 8♀. Carmi: Mar. 9, 1928, 3♂, 4♀. Castle Rock: Apr. 3, 1928, 1♀. Charleston: Mar. 9, 1930, 9♂, ♀♀; Mar. 22, 1931, 11♀. Chicago: Mar. 25, 1910, 1♂. Chrisman: Mar. 9, 1928, 1♀. Como: Mar. 11, 1928, 2♂. Danville: Jan. 11, 1928, 1♀; Mar. 11, 1928, 3♂, 2♀. Decatur: Mar. 15, 1930, 1♂, 2♀; Mar. 27, 1931, 2♀. Dixon: Apr. 3, 1928, 2♂, 2♀. East Peoria: Apr. 10, 1912, 3♀. Elizabethtown: Mar. 7, 1928, ♂♂, ♀♀. Elmwood: Apr. 1, 1928, 1♂, 2♀. Evansville: Feb. 3, 1934, ♂♂, ♀♀. Georgetown: Mar. 9, 1928, 13♂, 19♀. Golconda: Mar. 7, 1928, 2♀. Grayville: Mar. 8-9, 1928, 11♂, 10♀. Hamlet: Apr. 2, 1928, 1♂, 4♀. Havana: Apr. 21, 1898, 1♀. Homer: Mar. 21, 1905, 18♀; Mar. 1, 1929, ♂♂, ♀♀; Mar. 21, 1931, ♀♀. Humboldt: Feb. 3, 1928, ♂♂, ♀♀. Kampsville: Jan. 29, 1932, 1♀. Kankakee: Mar. 25, 1928, 2♂, 12♂. Lawrenceville: Mar. 9, 1928, ♂♂, ♀♀. Lexington: Mar. 25, 1928, 6♀. Louisville: Feb. 2, 1928, 1♂, 1♀. Mackinaw: Apr. 1, 1928, 1♂. Maquon: Apr. 1, 1928, 7♂, 33♀. Mahomet: Jan. 15, 1928, 4♂, 4♀; Apr. 4, 1929, 1♂, 2♀. Marengo: Apr. 4, 1928, 1♀. Mascoutah: Mar. 3, 1928, 1♂. Monmouth: Apr. 2, 1928, 1♂, 3♀. Mounds: Feb. 2, 1934, 1♂. Muncie: Mar. 16, 1907, 5♀; Mar. 7, 1909, 1♀; Jan. 2-11, 1928, ♂♂, ♀♀; Feb. 27, 1928, 3♂, 15♀; Mar. 31, 1928, 1♂. New Athens: Mar. 3, 1928, 1♂. New Memphis: Mar. 3, 1928, 16♂, 6♀. Norwood: Apr. 2, 1928, 1♂. Oakwood: Feb. 24-Mar. 26, 1927, ♂♂, ♀♀; Jan. 2-11, 1928, ♂♂, ♀♀; Feb. 3, 1928, 3♂, 4♀; Feb. 27, 1928, ♂♂, ♀♀; Mar. 31, 1928, 1♀. Ocoya: Mar. 24, 1928, 1♀. Oregon: Apr. 3, 1928, 1♀. Palos Park: Mar. 15, 1933, ♂♂, ♀♀. Paris—Chrisman: Mar. 9, 1928, 3♂, 6♀. Pekin: Apr. 12, 1912, 1♂. Pontiac: Mar. 25, 1928, 3♂, 13♀. Rockford: Apr. 3, 1925, 2♂. Seymour: Mar. 20-24, 1928, 1♂, 7♀. Sparland: Feb. 2, 1932, 1♂. Sterling: Apr. 3, 1928, 2♂, 9♀. St. Joseph: Apr. 2, 1905, 1♀; Feb. 11, 1928, ♂♂, ♀♀. Towanda: Mar. 24, 1928, 8♀. Union Hill: Mar. 25, 1928, 4♀. Urbana: Mar. 11, 1887, 1♀; Apr. 16, 1899, 1♂, 1♀; Mar. 11, 1911, 1♀; Mar. 18, 1927, 1♀; Jan. 14-16, 1928, ♂♂, ♀♀; Feb. 2, 1928, 5♂, 4♀. Walnut Prairie: Mar. 8, 1928, 2♀. White Heath—Mahomet: Mar. 25, 1928, 1♂, 4♀.

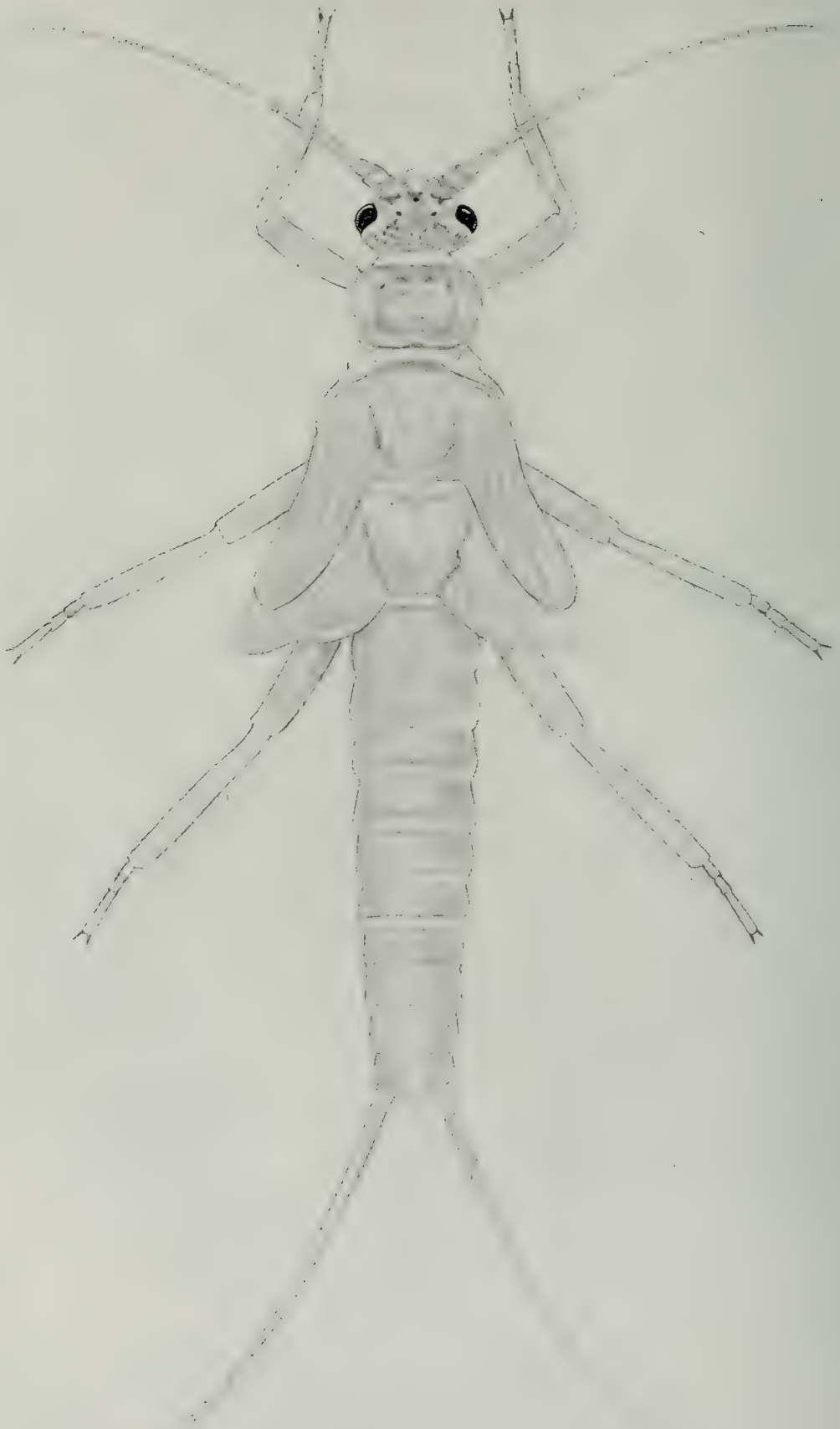


Fig. 277.—*Taeniopteryx parvula*, NYMPHAL FEMALE.

Nymphs.—Charleston (Embarrass r.): Dec. 14, 1930. Danville (Salt Fork r.): Jan. 2–11, 1928. Duncan Mills (Spoon r.): Mar. 23, 1932. Elizabethtown (Ohio r.): Mar. 7, 1928. Georgetown (Little Vermilion r.): Mar. 9, 1928. Grayville (Wabash r.): Mar. 8, 1928. Homer (Salt Fork r.): Mar. 21, 1914; Nov. 5–23, 1927; Mar. 1, 1929. Hutsonville (Wabash r.): Nov. 28, 1928. Mounds (Ohio r.): Feb. 2, 1934. Muncie (Stony cr.): Oct. 25—Nov. 23, 1927; Feb. 3, 1928. New Memphis (Kaskaskia r.): Mar. 3, 1928, exuviae. Oakwood (Salt Fork r.): Feb. 24—Mar. 10, 1927; Oct. 11—Nov. 23, 1927; Jan. 7—Feb. 27, 1928; Nov. 2, 1929; Dec. 27, 1930. Paris—Chrisman (Brouilletts cr.): Mar. 9, 1928, exuviae. Pekin (Illinois r.): Apr. 12, 1912. Peoria (Illinois r.): Apr. 11, 1912. Rock Island (Rock r.): Apr. 2, 1928; Apr. 10, 1931. White Heath (Sangamon r.): Feb. 21, 1928.

Reared from nymphs.—Elizabethtown (Ohio r.): Mar. 7, 1928. Rock Island (Rock r.): May 3, 1931.

Mating pairs.—Oakwood: Feb. 3, 1928; Mar. 21, 1929. Georgetown: Mar. 9, 1928.

Taeniopteryx parvula Banks

Figs. 190, 214, 223, 277.

Taeniopteryx parvula Banks (1918) p. 7. Original description (♂, ♀).

Taeniopteryx parvula Frison (1929) p. 383. Nymphal description (♂, ♀).

Field work since 1929 has corroborated the statement made then, that *parvula* was "the rarest of the three large species of winter stoneflies occurring in Illinois." Thus far the nymphs have been found in only two of the largest rivers, the Ohio and the Rock, and the adults at localities adjacent to these rivers and the Wabash. The species has also been recorded from the District of Columbia, Maine, Maryland, Massachusetts, Minnesota, New Jersey and Wisconsin.

Our records of *parvula* indicate that it occupies a later position in the seasonal succession of adults than *nivalis*, appearing about the first of March and continuing until about the last of April. A mating pair was taken April 3 at Dixon, clinging to the side of a tree where the female was feeding on blue-green algae. Features of the apical abdominal segments are shown in figs. 190, 223.

No detailed description of the nymph of this species was published in 1929, due to lack of material. Main characters of the immature form, however, were indicated, based upon cast skins and the association of one cast skin with its reared adult. Additional nymphal material now substantiates this earlier characterization. Also, the nymph has since been described by Claassen (1931). The mouthparts are practically identical with those of *T. nivalis*.

Adults.—Dixon: Apr. 3, 1928, 2♂, 6♀. Elizabethtown: Mar. 7, 1928,



Fig. 278.—*Strophopteryx fasciata*, NYMPHAL FEMALE.

6♂, 8♀. Golconda: Mar. 17, 1932, 1♂. Grayville: Mar. 8, 1928, 7♂, 14♀. Oregon: Apr. 3, 1928, 1♂, 9♀. Rockford: Apr. 3, 1925, ♂♂; Apr. 23, 1926, 2♂. Sterling: Apr. 3, 1928, 2♀.

Nymphs.—Elizabethtown (Ohio r.): Mar. 7, 1928, exuviae. Oregon (Rock r.): Apr. 3, 1928, exuviae. Rock Island (Rock r.): Apr. 10, 1931. Sterling (Rock r.): Apr. 27, 1932.

Mating pairs.—Dixon: Apr. 3, 1928, 1 pair.

Strophopteryx Frison

Frison (1929) p. 374. Genotype *Semblis fasciata* Burmeister = *Strophopteryx fasciata* (Burmeister), original designation; monotypic.

This genus was originally proposed by the author (1929) in the belief that *Taeniopteryx* as then used by American students was a heterogeneous assemblage of species which formed at least three distinct and easily separable groups equivalent to genera. This conclusion, based upon study of adults and nymphs, is supported by a more comprehensive study of the North American stonefly fauna made since it was drawn. To date the genus has but one North American species, as below.

Strophopteryx fasciata (Burmeister)

Figs. 2b, 56, 86, 116, 148, 172, 199, 226, 255, **278**, 279, 280.

Semblis fasciata Burmeister (1839) p. 875. Original description.

Strophopteryx fasciata Frison (1929) p. 385. Nymphal description (♂, ♀).

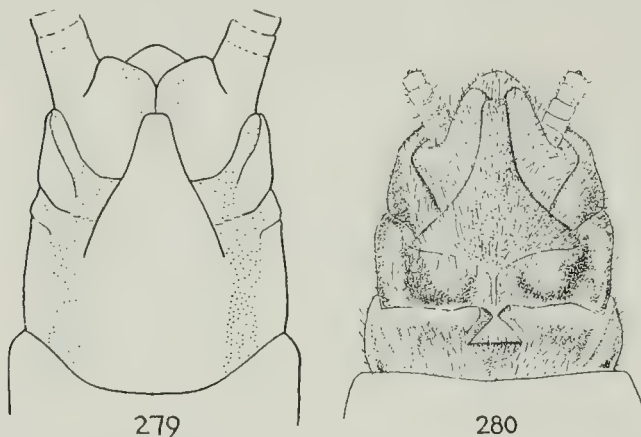
This species and *T. nivalis* (Fitch) are our two largest winter stoneflies, but *fasciata* is less abundant and has a more localized distribution. It has also been recorded from the District of Columbia, Kansas, Maryland, Massachusetts, Minnesota, Missouri, New York, North Carolina, Pennsylvania, Tennessee, Virginia and West Virginia.

In my paper of 1929 considerable was published on habits of the adults and nymphs, as well as were detailed descriptions of the previously unknown nymphs. Little information can be added now.

The adults reach their maximum abundance in this state during the last half of March and first of April, according to latitude. There is only one generation a year. Consistently this species appears later than *T. nivalis*, but the two are often found together because they frequent the same places and their times of adult emergence overlap. I have observed them in thousands feeding upon elm blossoms near the Rock river, but do not doubt that other vegetation contributes to their diet. The females, except for the position of the body while the egg mass is being formed, have egg laying habits similar to those of *Taeniopteryx* and *Allocapnia* (Frison 1929). The sexes have been associated definitely by the collection

of mating pairs, and adults with nymphs by the rearing of both sexes. Characteristics of the apical abdominal segments are shown in figs. 199, 226, 280, and the type of wing venation by fig. 172.

The nymphs are essentially herbivorous. Although found in the same rivers and often in close association with *T. nivalis* they prefer the more stony portions of the stream bed near riffles. The small nymphs are not found by ordinary methods of collecting until late fall, and growth proceeds most rapidly during December, January and February. Nymphal mouthparts are shown in figs. 56, 86, 116, and the apical abdominal segments of the female in fig. 279.



Figs. 279-280.—VENTRAL VIEW OF FEMALE TERMINAL ABDOMINAL SEGMENTS OF *Strophopteryx fasciata*. 279.—Nymph. 280.—Adult. Shape of subgenital plate of adult female is indicated in the nymph.

Taeniopteryx (in the broad sense as used at the time of the paper by Walsh) in Illinois, is very common at Rock Island, and markings of wings have always assisted in its correct identification. The record of Walsh was also overlooked in my paper in 1929.

The Walsh (1862) record of *Taeniopteryx fasciata* from Rock Island, Ill. certainly refers to this species. Walsh's identification of *fasciata* was checked by Hagen, whose placement of *fasciata* has been accepted by Needham and Claassen (1925). The latter authors however overlooked in their monograph the placing in synonymy of the Walsh record. *Fasciata* is one of the two commonest species of

Adults.—Algonquin: Apr. 1, 1907, 1♀. Barstow: Apr. 2, 1928, 1♂. Carmi: Mar. 8, 1928, 2♂, 1♀. Charleston: Mar. 9, 1930, 1♂; Mar. 22, 1931, 1♀. Como: Mar. 11, 1928, ♂♂, ♀♀. Danville: Mar. 11, 1928, ♂♂, ♀♀. Dixon: Apr. 3, 1928, ♂♂, ♀♀. Elizabethtown: Mar. 7, 1928, 1♀. Erie—Denrock: Apr. 3, 1928, 2♂, 2♀. Grand Detour: Apr. 3, 1928, ♂♂, ♀♀. Grayville: Mar. 8, 1928, 10♂, 7♀. Havana: Apr. 21, 1898, 1♀; Apr. 30, 1912, 2♀. Herod: Mar. 6, 1928, 1♀. Homer: Mar. 19, 1907, 1♂. Kankakee: Mar. 25, 1928, 1♂, 1♀. Keithsburg: Apr. 4, 1932, ♀♀. Lexington: Mar. 25, 1928, 6♂, 5♀. Mackinaw: Apr. 1, 1928, 2♂, 10♀. Mahomet: Apr. 4, 1929, 1♂, 3♀. Maquon: Apr. 2, 1928, ♂♂, ♀♀. Moline—Erie: Apr. 2, 1928, 1♂. Muncie: Apr. 4, 1909, 1♀; Mar. 31, 1928, 4♂, 8♀. Oakwood: Feb. 24–26, 1927, 15♂, 13♀; Mar. 4, 1927, 5♂, 5♀; Mar. 17, 26, 1927, ♂♂, ♀♀; Feb. 3, 1928, ♂♂, ♀♀; Feb. 27, 1928, ♂♂, ♀♀; Mar. 31, 1928, 13♂, 27♀; Mar. 21, 1929, ♂♂, ♀♀. Ocoya: Mar. 25, 1928, 1♂. Oregon: Apr. 3, 1928, 3♂, 4♀. Paris—Chrisman: Mar. 9, 1928, 1♂. Pontiac: Mar. 25, 1928,

3♂, 3♀. Rockford: Apr. 21, 1926, 2♂, 4♀. Rock Island: Apr. 3, 1928, ♂♂, ♀♀; Apr. 10, 1931, 2♂, 4♀; Apr. 3, 1932, ♂♂. Seymour: Mar. 24, 1928, 1♀; Mar. 22, 1930, 1♀. Sterling: Apr. 3, 1928, ♂♂, ♀♀. Towanda: Mar. 24, 1928, 6♂, 4♀. Union Hill: Mar. 25, 1928, 2♂. Urbana: Mar. 18-23, 1928, 3♀. White Heath: Feb. 21, 1928, 1♂.

Nymphs.—Charleston (Embarrass r.): Mar. 22, 1931. Dixon (Rock r.): Apr. 3, 1928. Golconda (Big Grand Pierre r.): Mar. 7, 1928. Grayville (Wabash r.): Mar. 8, 1928. Homer (Salt Fork r.): Nov. 23, 1927. Lexington (Mackinaw r.): Mar. 25, 1928, exuviae. Mackinaw (Deep cr.): Apr. 1, 1928, exuviae. Mt. Carmel (Wabash r.): Apr. 2, 1932. Oakwood (Salt Fork r.): Feb. 24-26, Mar. 10, Nov. 23, 1927; Jan. 11, Feb. 27, Mar. 4, 1928. Oregon (Rock r.): Apr. 3, 1928. Pontiac (Vermilion r.): Mar. 25, 1928, exuvia. Rockford (Rock r.): Apr. 3, 1928. Rock Island (Rock r.): Apr. 2, 1928; Apr. 10, 1931; Mar. 2, Apr. 3, 1932. Sterling (Rock r.): Apr. 3, 1928. Towanda (Money cr.): Mar. 24, 1928, exuviae. White Heath (Sangamon r.): Feb. 21, 1928.

Reared from nymphs.—Oakwood (Salt Fork r.): Mar. 10, 1927.

NEMOURIDAE

Only one species of this family as now defined is known to occur in Illinois—*Nemoura venosa* Banks. *Nemoura* (*s. lat.*) contains a large number of North American species which are distributed chiefly in the western, northern and northeastern parts of this continent. That central Mississippi valley states have a paucity of species is indicated by occurrence of only one species in Illinois and lack of records from most states in this general region.

European students of the stoneflies have separated the genus *Nemoura* into subgenera based upon the modifications presented by the apical abdominal segments and appendages, which system has been supplanted by one based on arrangement and type of the nymphal tracheal gills. The Illinois species *venosa* Banks fits the characterization given for the subgenus *Amphinemura* Ris (1902).

Nemoura Latreille

Latreille (1796) p. 101. Genotype *Nemoura* (*Nemura*) *variegata* Olivier, subsequent designation of Enderlein (1909).

Nemoura [AMPHINEMURA] *venosa* Banks

Figs. 29, 58, 89, 119, 152, 173, 189, 264, **281**, 282.

Nemoura venosa Banks (1897) p. 21. Original description (♂, ♀).

Nemoura venosa Claassen (1931) p. 95. Nymphal description.

Except for the various descriptions and records of Banks (1897-1920),

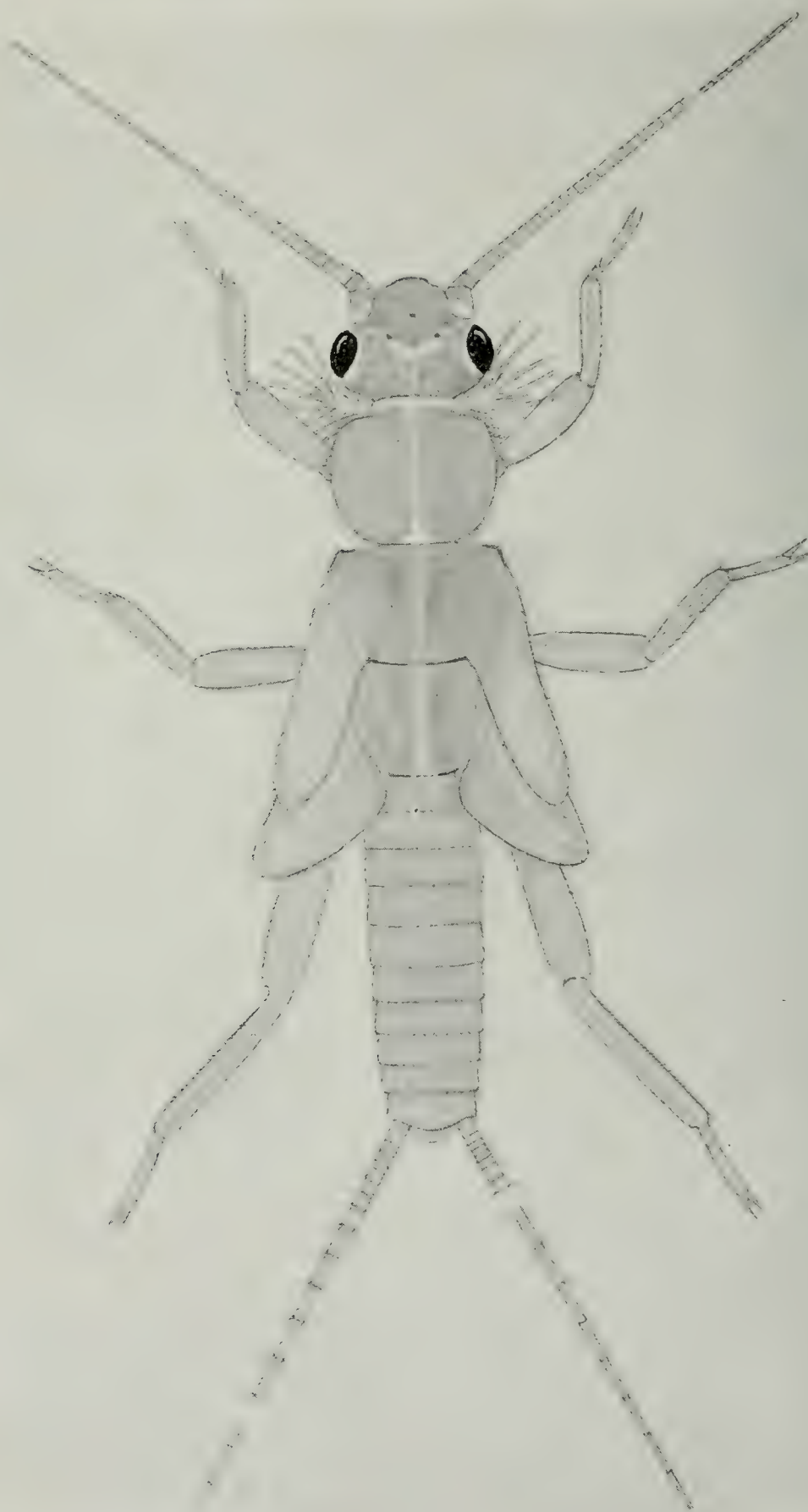


Fig 281.—*Nemoura venosa*, NYMPHAL FEMALE.

the records of Walsh (1862, 1863) under other names, and the nymphal description by Claassen (1931), nothing has been published concerning this species. Our Illinois records indicate that it is likely to be found in any part of the state but is particularly abundant in the small streams of southern Illinois. The adults begin to appear in April and are found as late as June. I believe that the adults feed on tender vegetation and algae growing near the streams they frequent. Association of the sexes and nymphs with adults is based upon mating pairs and reared specimens. The structural details of the terminal abdominal segments are shown in figs. 189, 282, and the type of wing venation in fig. 173.

The nymphs, fig. 281, apparently make their greatest and most rapid growth in spring and all our evidence indicates but one generation a year. They are herbivorous and are most frequently encountered in small streams with sandy bottoms where they crawl between submerged leaves and under other decaying vegetation. Their hairy bodies often are the cause of their becoming more or less covered with debris and being mistaken for other aquatic nymphs.

Chief morphological features of the nymph have been described by Claassen (1931). They differ from those of all other Illinois species by the inclusion of four bunches of gill filaments, with five to nine filaments in a bunch, transversely arranged on the ventral cervical region between head and thorax, fig. 264, and absence of these filaments elsewhere. Nymphal mouthparts of this species are shown in figs. 29, 58, 89, 119, 152.

In 1862 Walsh published a record of "*Nemoura completa* Walker" which according to the introduction of his article came from the vicinity of Rock Island, Ill. The presence of *Nemoura venosa* Banks in this state and its more or less general distribution leads me to conclude that the *completa* of Walsh should be placed in the synonymy of *venosa*. Just what the true *N. completa* Walker is could not be determined by Needham and Claassen at the time of their monograph and it may be one of many species of *Nemoura*.

A year later, in 1863, Walsh again referred to *N. completa* and in addition mentioned five specimens of "*Nemoura albidipennis* Walker" from Illinois. There is a damaged specimen of *Nemoura venosa* Banks in the SURVEY collection which was determined by Walsh as "*Nemoura albidipennis* Walker." The remarks by Walsh concerning the difference between the specimens he determined as *completa* and *albidipennis* are of

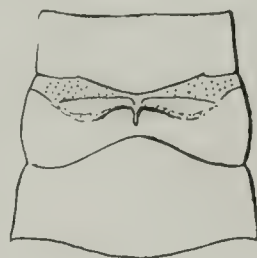


Fig. 282.—VENTRAL VIEW OF TERMINAL ABDOMINAL SEGMENTS OF *Nemoura venosa*, ADULT FEMALE.

such a nature as to lead me to believe that his supposedly two species of *Nemoura* were slightly different colored specimens of the same species. Further evidence that Walsh confused *venosa* under different names is found in the fact that in the SURVEY collection is a male of *Nemoura venosa* from "Ky." which was originally determined by Walsh as "*Nemoura perfecta* Walker." I believe that this record has never been published.

Needham and Claassen (1925) have recorded this species from Lake Forest, Ill. and also from Georgia, Massachusetts, New York, North Carolina, Ontario and Pennsylvania.

Adults.—Fountain Bluff: May 14, 1932, ♂♂, ♀♀. Herod: Apr. 20, 1930, 1♂, 1♀. Muncie: May 20, 1909, 1♂. New Columbia: Apr. 3, 1932, 1♀; Apr. 21, 1932, ♂♂, ♀♀; Apr. 22, 1932, 4♂, 5♀; June 10, 1932, 1♀. Rockford: Apr. 23, 1926, 1♀. Watson: Apr. 23, 1932, ♂♂, ♀♀. "N. Ill.": 1♂.

Nymphs.—Dixon Springs (trib. of Sugar cr.): Apr. 2, 1932. Harrisburg (Blackman cr.): Apr. 2, 1932. Herod (Gibbons cr. and Blackman cr.): Apr. 20, 1932. Marshall (trib. of Big cr.): May 11, 1933. New Columbia (Clifty cr.): Mar. 26, Apr. 3, 21, 22, 1932. Watson (trib. of Little Salt cr.): Apr. 4, 7, 1932.

Reared from nymphs.—Watson (trib. of Little Salt cr.): Apr. 27, May 1, 1932.

Mating pair.—Fountain Bluff: May 15, 1932.

LEUCTRIDAE

Here is another family represented in Illinois by a single species. The genus *Leuctra* contains 16 species distinguished primarily by differences in structure of the apical abdominal segments. Distributional records indicate a paucity of species of *Leuctra* in the central states and a maximum abundance in the mountainous or hilly regions of the United States and Canada.

I consider as belonging to this family the genera *Perlomyia* Banks, *Megaleuctra* Neave and *Eucapnopsis* Okamoto. These three genera are western rarities in collections and with their nymphal stages unknown. *Megaleuctra* was placed by Neave (1934) in the family Nemouridae; a family used by him in its broadest sense and containing the genus *Leuctra*. I do not share the view that *Megaleuctra* presents an obstacle to the recognition of Leuctridae, Nemouridae and Taeniopterygidae as separate families. All these groups possess characters in common, evidence of common line of descent, but are nevertheless distinguishable as separate natural units, which I consider to have been correctly evaluated as of family rank by most recent European students of stoneflies.

Neave has placed *Eucapnopsis* Okamoto (1922) in the family Capnii-

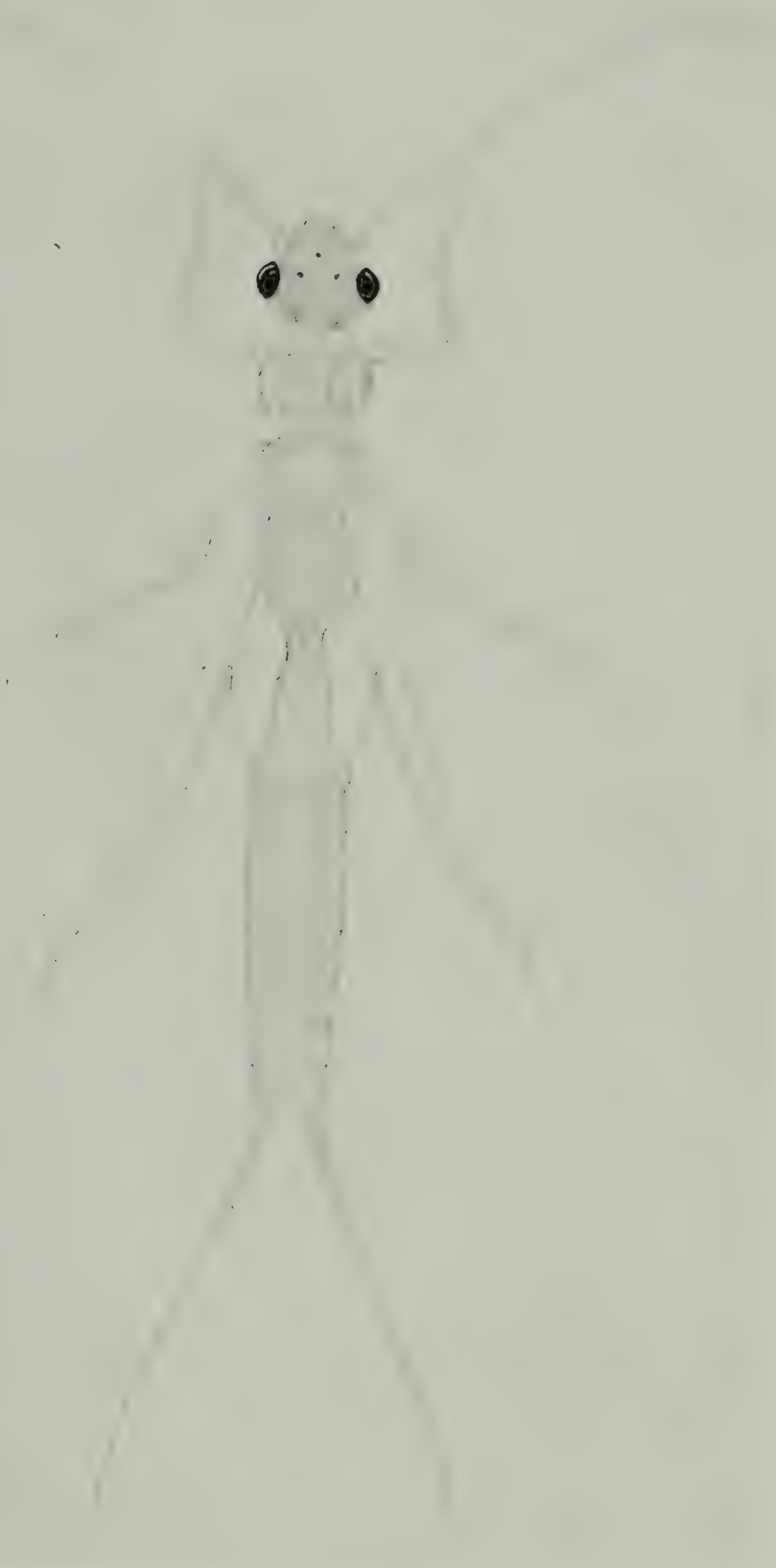


Fig. 283.—*Leuctra claasseni*, NYMPHAL FEMALE.

dae, calling attention at the same time to its nemourid (*s. lat.*) affinities. In the key to families for this paper *Eucapnopsis* runs to the Leuctridae. The short cerci of the adult are the strongest warranty for this placement.

Leuctra Stephens

Stephens (1835) p. 144. Genotype *Leuctra geniculata* Stephens, subsequent designation of Enderlein (1909).

Leuctra claasseni Frison

Figs. 59, 88, 118, 153, 178, 194, 230, 258, **283**, 284, 285.

Leuctra claasseni Frison (1929) p. 404. Original description (adult ♂; nymphal ♂, ♀).

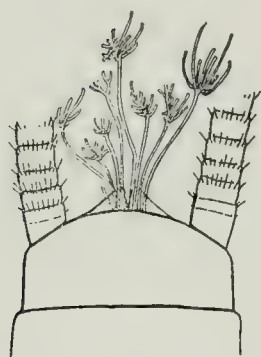


Fig. 284.—DORSAL VIEW OF TERMINAL ABDOMINAL SEGMENTS OF *Leuctra claasseni*, NYMPHAL FEMALE, SHOWING ANAL GILLS.

Since publication of the original description the female has been captured and more distributional records have been obtained. All data indicate that *claasseni* is confined in Illinois to streams in the old Ozarkian uplift of the extreme southern part of the state. In addition to the Illinois material I have seen specimens which were collected in Missouri and in Oklahoma.

The adults are sometimes found in February but most of our material has been collected during March or April. The nymphs occur in small streams along with nymphs of *Allocapnia*, *Nemoura* and *Isoperla*. However, instead of congregating under decaying leaves and debris as do most species of these genera, the nymphs of *Leuctra claasseni* prefer to hide singly under stones in swifter water. They are undoubtedly herbivorous.

The adult male and the nymphs have been described in detail (Frison 1929), but at that time the anal gills of the nymph were overlooked due to the fact that they are easily broken off and often are deeply retracted. These gills, fig. 284, consist of five to nine delicate filaments branched at the tips. The characteristic appearance of the nymph, with wing pads paralleling the long axis of the body, is shown in fig. 283, and characters of the mouthparts in figs. 59, 88, 118. The forewing, fig. 178, differs from the related *Nemoura* by lack of a crossvein in the apical marginal space distad the tip of the subcostal vein.

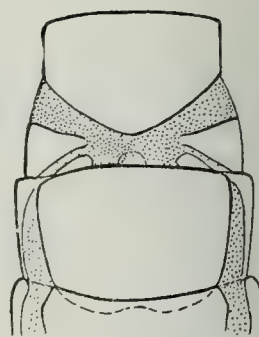


Fig. 285.—VENTRAL VIEW OF EIGHTH AND NINTH ABDOMINAL SEGMENTS OF *Leuctra claasseni*, ADULT FEMALE.

Female.—The adult female is much like the male in general appearance and in most structural details. The most distinctive features of the female, those presented by the eighth and ninth abdominal sternites, are shown in fig. 285. No other described species of *Leuctra* has a similar aspect. The abdomen is mostly membranous, except that its extreme tip, a series of narrow elongate spots along the sides and the median area of the sternites are heavily sclerotized. The subgenital plate scarcely protrudes over the ninth sternite, fig. 285, and in the middle of the membrane along the posterior margin of the plate there is a knoblike projection, flanked on each side by two heavily sclerotized spots.

Allotype, female.—Herod, Ill. (Hicks Branch): Apr. 22, 1932, collected by H. H. Ross and C. O. Mohr. Deposited in the collection of the ILLINOIS STATE NATURAL HISTORY SURVEY.

Adults.—Fountain Bluff: Feb. 22, 1933, 1♀. Harrisburg: Apr. 2, 1932, ♂♂, ♀♀. Herod: Mar. 6, 1928, 2♂; Apr. 20–22, 1932, 1♂, 1♀.

Nymphs.—Harrisburg (Blackman cr.): Mar. 6, 1928; Apr. 2, 1932. Herod (Gibbons cr.): Mar. 6, 1928.

Since the species has not been recorded from other states the following records are given also. **Adults.**—Cedar, Comanche county, Okla.: Feb. 28, 1932, 11♂, 12♀. Comanche county, Okla.: Feb. 27–28, 1932, 64♂, 48♀. Honey creek, Murray county, Okla.: Mar. 20, 1932, 1♂, 7♀. Wichita National Forest, Okla.: Mar. 3, 1929, 6♂, 14♀. **Nymphs.**—St. Clair—Rolla (Little Bourboise cr.), Mo.: Jan. 30, 1932, 1 nymph. Cedar, Comanche county, Okla.: Feb. 28, 1932. Wichita National Forest, Okla.: Mar. 3, 1929. The specimen from Missouri was collected by Dr. H. H. Ross and Dr. C. O. Mohr of the SURVEY, and those from Oklahoma by Dr. R. D. Bird and his associates, then of the University of Oklahoma.

CAPNIIDAE

In North America this family includes three genera, *Capnia*, *Capnura* and *Allocapnia*. *Capnura* is known only from Washington and contains but a single species. *Capnia*, a rarity in Illinois, is rich in species but is primarily a genus of the western states and Canada. *Allocapnia*, containing eight species, takes the place of *Capnia* in the eastern and central states and is of special interest to the student of Illinois stoneflies because of the abundance of some of the species, peculiarities in their distribution, and the correlation of growth of nymphs and emergence of adults with the coldest months of the year.

KEY TO GENERA

Adults

Mesosternum with posterior margin of large, heavily or darkly sclerotized medial area (mesobasisternite) strongly produced backwards, fig. 287. Second trans-

CAPNIIDAE—KEY TO GENERA—CONT'D

- verse vein (subcosta) of forewing uniting with margin of forewing (costa) much before the cord (more or less transverse line-up of crossveins and some longitudinal veins beyond middle of wing). Anal field or lobe of hind wing large and nearly as long as front portion.....**Allocapnia**, p. 357
- Mesosternum with posterior margin of large, heavily or darkly sclerotized medial area (mesobasisternite) nearly transverse, fig. 286. Second transverse vein of forewing extending to or nearly to the cord. Anal field of hind wing reduced and not extending much farther than half the length of front portion....
.....**Capnia**, p. 356

Nymphs

- Wing pads present in most species, absent or rudimentary in at least one species. Anal field of hind wing pad, when present, extending far beyond middle of wing case, fig. 298.....**Allocapnia**, p. 357
- Wing pads always present. Anal field of hind wing pad not extending much beyond the middle of the wing case.....**Capnia**⁶, p. 356

Capnia Pictet

Pictet (1841) p. 320. Genotype *Capnia nigra* Pictet, subsequent designation of Enderlein (1909).

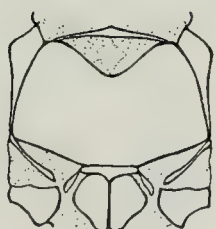
Capnia (*vernalis* Newport?)

Figs. 174, 176, 286, 288.

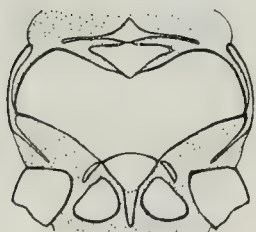
No additional specimens of this stonefly have been captured in Illinois since the one recorded by myself in 1929 and I can add nothing further to the statements made at that time, which were as follows:

"A unique female belonging to this genus was collected at Grayville, Ill., March 8, 1928, by T. H. Frison and H. H. Ross. Since no keys exist for the determination of the females of this genus, and males were not found to associate with the female, the Illinois representative of this genus must go unnamed for the present. Only one species, *Capnia vernalis* Newport, of the 19 known North American members of the genus has been found east of the Rocky mountains. This is suggestive that the Illinois specimen is this species, but it may be an undescribed one or a western form ranging eastward.

"Structurally, the female agrees well with the description of the female of *Capnia vernalis* Newport



286



287

Figs. 286-287.—
MESOSTERNUM.
286.—*Capnia* sp.
287. — *Allocapnia*
mystica.

⁶ To date only one species of nymph belonging to this genus has been described from North America and until now no nymphs of this genus have been found in Illinois. The characters used to distinguish the nymph in this key are based upon statements of Claassen (1931).

as given by Needham and Claassen (1925), but since the differential or specific characters of the females of the genus have not been defined this cannot be taken as conclusive proof of specific identity. It is included in this paper because its date of capture places it in our Illinois list of winter stoneflies, and in hope that mention of it will lead to interested parties discovering the male. Furthermore, the record is important because the genus *Capnia* has not heretofore been recorded from any state in the Mississippi basin."

The nymph of *Capnia vernalis* Newport has been recently described and figured by Claassen (1931). The nymphs are said to be herbivorous and live in leaves and debris in small upland streams. In general they are very suggestive of the genus *Allocaupnia*.

The "*Capnia minima?* Newport" of Walsh (1862) is most certainly an *Allocaupnia* and probably the species *vivipara*.

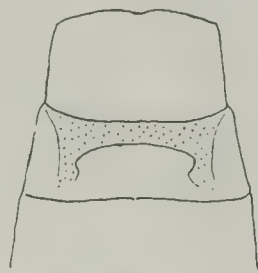


Fig. 288. — ABDOMINAL STERNITES OF *Capnia* sp., ADULT FEMALE.

Allocaupnia Claassen

Capnella Claassen (1924) p. 43. Preoccupied. Genotype *Capnella granulata* Claassen = *Allocaupnia granulata* (Claassen), original designation.

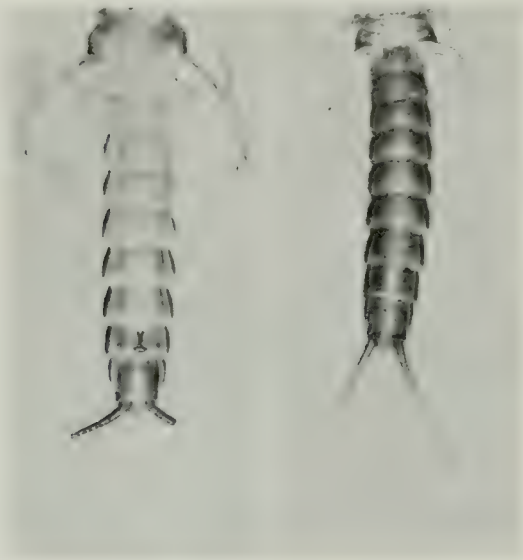
Allocaupnia Claassen (1928) p. 667. New name.

A summary of the distributional records of the five species of *Allocaupnia* known at the time of the monograph by Needham and Claassen (1925) might have been taken to indicate then that the northeastern part of the United States was the general center of distribution for this genus. In my report of 1929 Illinois records were given for all except one of the known species of *Allocaupnia* and two previously unknown species were described as new based upon Illinois material. The present paper adds another new species from Illinois and extends the range of the genus as far west and south as Oklahoma. It is evident therefore that the genus *Allocaupnia* is quite at home in the streams of the middle Mississippi valley and is to be expected in many states from which it has not been recorded.

It is further evident from study of the distributional maps of the seven species occurring in Illinois that the extreme central eastern part of Illinois and the Ozarkian uplift region in the extreme southern part of the state are especially favorable to the development of a varied *Allocaupnia* fauna. In the central and northern parts of the state, except for the eastern central portion draining into the Wabash river, only two species of this genus have been found. This suggests to me that the center of dispersal for *Allocaupnia* is to the south and east of Illinois and that the

stonefly lists of Georgia, Indiana, Kentucky, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia and West Virginia are due for many additions when their winter fauna is studied.

The males are easy to identify because of the presence of peculiar and varied raised structures on the apical abdominal tergites. At the time of their monograph Needham and Claassen (1925) stated that "in the females



Figs. 289-290.—VENTRAL VIEW OF *Allocapnia*, NYMPHAL FEMALES. 289.—(Left), *A. granulata*, showing indication of characteristic subgenital plate of eighth sternite. 290.—(Right), *A. recta*.

the genital structures are of little value as key characters" and no attempt was made to key the females. The capture of males and females *in coitu* enabled the writer (1929) to associate the males and females of the various species and to point out characters by which these females could be identified.

When the nymphs were first described (Frison 1929) the difficulty in sharply separating or identifying the nymphs of the various species was recognized and stated as follows:

"Such rearings and collections have served to remove all doubts regarding the correct generic association of the nymphs with their adults

and, with the exception of the genus *Allocapnia*, for the species as well. The difficulty with the nymphs of *Allocapnia* is due to the fact that this genus affords an exceptionally good example of a homogeneous group. Specific differences in the adults of this group are well marked and constant, but they consist for the most part of genital or accessory genital characters which are not developed in the nymphs in a comparable manner. There are however certain characters which permit the ready separation of all nymphs of this genus into males and females and the identification and keying of several of the males. Although it is possible for one well acquainted with the adults and nymphs of *Allocapnia* from Illinois to name most of the remaining species not included in the key (because of knowledge of the seasonal and geographical distribution of the species in the state, streams where certain species are liable to be found, slight indications of structural characters later apparent in the adults, etc.), it is impossible to formulate a key which would not at times be misleading to others. Therefore, instead of constructing a key based upon exceptional specimens of full grown nymphs, in which structural characters of adults



Fig. 291-295.—DORSAL VIEWS OF *Allocapnia*, NYMPHS AND ADULTS. 291.—(Top left), *A. recta*, nymphal male. 292.—(Top center), *A. vivipara*, adult female, showing short wings and darkly sclerotized eighth, ninth and tenth abdominal segments. 293.—(Top right), *A. vivipara*, adult male, showing lack of wings. 294.—(Bottom left), *A. granulata*, adult female, showing long wings. 295.—(Bottom right), *A. granulata*, adult female, with wings clipped to show darkly sclerotized ninth and tenth abdominal segments.

can be plainly deciphered in advance, attention is called to such specimens under each species of *Allocaḡnia*. The chances of naming the nymphs of this genus, particularly the females, increase with the age of the specimens, and *vice versa*. Many of the full grown female nymphs of *Allocaḡnia* show in clear outlines what the ventral structure of the eighth abdominal segment of the adult will be, fig. 289, while others of similar size, due to a lack of contrasting sclerotization at time of capture, show nothing, fig. 290. In the males, also, a heavily sclerotized knoblike structure may frequently be seen beneath the dorsal integument of the ninth abdominal segment, and in exceptional cases it is so well delineated that the species can be recognized by it."

Much additional nymphal material from various parts of the state and of known identity has confirmed our earlier statements regarding the difficulty of keying and identifying the nymphs of *Allocaḡnia* because of their rather uniform appearance.

The time of emergence of the adults of the various species presents a good seasonal succession beginning in November and continuing into April. Like other Illinois winter stoneflies, *Taeniopteryx* and *Strophopteryx*, the adults feed upon blue-green algae and the nymphs are herbivorous. The nymphs of most species are found in small streams but several of the species likewise live in the larger rivers.

Claassen (1931) has published a record of *Allocaḡnia incisura* Claassen from Charleston, Ill., which is not accepted in this paper. Extensive collecting by myself and assistants in the region about Charleston and in all parts of Illinois has failed to disclose the presence of *incisura* in this state. Correspondence with Dr. Claassen reveals that the material upon which his record was based is now lost. In view of the fact that so many species of *Allocaḡnia* are now known from Illinois, the possibility of *incisura* occurring in this state is not to be denied. However, until actual specimens upon which to base such a state record are available to us, it seems advisable to leave this species off our Illinois list.

KEY TO SPECIES

Adults

1. Eighth dorsal abdominal segment with a raised knoblike structure, figs. 221, 224. Wings either absent, abbreviated or extending nearly to apex of abdomen (males).....2
- Eighth dorsal abdominal segment without a raised knoblike structure, fig. 292. Wings never absent; either abbreviated or extending to or beyond apex of abdomen (females).....8
2. Wingless, fig. 293.....*vivipara*, p. 370
- Wings abbreviated or long, figs. 292, 294.....3

ALLOCAPNIA—KEY TO SPECIES—CONT'D

3. Seventh dorsal abdominal segment with a tubercle or knoblike structure similar to knob on the eighth dorsal abdominal segment.....4
 Seventh dorsal abdominal segment without a raised tubercle or knoblike structure similar to knob on the eighth dorsal abdominal segment.....5
4. Knoblike structure, fig. 222, on seventh dorsal abdominal segment large and conical, rising perpendicular to segment. Supra-anal process about as long as seventh and eighth abdominal segments combined. Wings usually extending little beyond third abdominal segment.....*forbesi*, p. 363
 Knoblike structure, fig. 225, on seventh dorsal abdominal segment slightly notched at tip, slightly inclined posteriorly. Supra-anal process only slightly longer than seventh dorsal abdominal segment. Wings extending about to seventh abdominal segment.....*illinoensis*, p. 365
5. Wings rarely extending backwards beyond fifth dorsal abdominal segment. Mid-dorsal area of abdominal segments darkly sclerotized and mid-dorsal longitudinal light stripe therefore absent. Species rarely found in Illinois in winter prior to January.....6
 Wings usually extending backwards beyond fifth dorsal abdominal segment. Mid-dorsal area of abdominal segments pale, contrasting with lateral margins; a mid-dorsal longitudinal light stripe therefore present. Species found in Illinois in fall or winter usually before January.....7
6. Knob on dorsum of eighth abdominal segment deeply divided along mid-dorsal line into two more or less conical tubercles; situated before posterior margin of ninth dorsal segment. Upper tip of supra-anal process (pronglike process recurved upward and forward over apical segments) with bulbous enlargement. Apical segments of abdomen with hairs not much longer than those on middle segments.....*pygmaea*, p. 367
 Knob on dorsum of eighth abdominal segment not so deeply divided along mid-dorsal line that two distinct and disconnected tubercles result; situated at apex of upward and backward directed hind margin of ninth dorsal segment, fig. 227. Upper tip of supra-anal process scarcely enlarged. Apical segments of abdomen with hairs much longer than those on middle segments.....*granulata*, p. 364
7. Knob arising at anterior margin of eighth abdominal tergite and extending backward and upward at a 45° angle, fig. 229; as high as length of seventh segment, apex of knob forming two small tubercles separated by a small cleft. Supra-anal process large, nearly two times as long when extended as eighth abdominal segment.....*mystica*, p. 366
 Knob arising near middle of eighth abdominal tergite about perpendicular to segment, height much less than length of seventh segment, apex of knob not cleft but forming a single, small, more or less round plateau-like area highest at anterior margin. Supra-anal process small, scarcely longer when extended than eighth abdominal segment.....*recta*, p. 367
8. Last three dorsal segments (8, 9 and 10) of abdomen entirely and darkly sclerotized, fig. 292. A wide longitudinal pale membranous stripe extending on dorsum of abdomen from base to hind margin of seventh segment..9
 Last two dorsal apical segments only (9 and 10) of abdomen entirely and darkly sclerotized, fig. 295. A wide longitudinal pale membranous stripe extending on dorsum of abdomen from base to hind margin of eighth segment..10

ALLOCAPNIA—KEY TO SPECIES—CONT'D

9. Posterior transverse margin of eighth ventral abdominal segment with a small rounded lobelike projection at its middle, fig. 217. A narrow transverse pale membranous strip visible between darkly sclerotized areas of seventh and eighth ventral abdominal segments in extended specimens.....
.....**forbesi**, p. 363
Posterior transverse margin of eighth ventral abdominal segment straight, without a projection at its middle, fig. 218. Darkly sclerotized areas of seventh and eighth ventral abdominal segments fused near middle, without a pale membranous strip between them, fig. 218.....**vivipara**, p. 370
10. Darkly sclerotized areas of seventh and eighth ventral abdominal segments fused near middle, fig. 215; without a pale membranous transverse strip between them.....**pygmaea**, p. 367
A narrow transverse pale membranous strip visible between darkly sclerotized areas of seventh and eighth ventral abdominal segments in extended specimens.....11
11. Posterior transverse margin of eighth ventral abdominal segment almost straight, fig. 213; at most with a small outward bulge at middle of margin.
.....**recta**, p. 367
Posterior transverse margin of eighth ventral abdominal segment with a conspicuous but very short, sunken projection a little less than one-third as wide as darkly sclerotized area of same segment.....12
12. Antennae stout, moniliform; basal and middle segments much broader than segments of maxillary palpi. Eighth abdominal sternite with postero-median process deeply inset or sharply delineated, figs. 212, 220. Larger species (body 7–9 mm.). Not found in Illinois in winter prior to January.....13
Antennae more slender, filiform; basal and middle segments not much broader than segments of maxillary palpi. Eighth abdominal sternite with postero-median process not so deeply inset or sharply delineated, fig. 219. Small species (body 6–8 mm.). Species reaching maximum abundance in Illinois in fall or winter prior to middle of January.....**mystica**, p. 366
13. Eighth abdominal sternite with base of posteriomedian process fused with basal portion of ninth ventral abdominal segment, fig. 220.**granulata**, p. 364
Eighth abdominal sternite with posteriomedian process inset in more membranous area and almost dividing basal part of sternite into two more or less distinct lateral areas, fig. 212.....**illinoensis**, p. 365

Nymphs

1. Nymphs with a conspicuous dorsal lobelike protuberence, fig. 297, at apex of abdomen (males).....2
Nymphs without a conspicuous dorsal lobelike protuberence, fig. 298, at apex of abdomen. Apical margin broadly rounded behind.....**females**⁷
2. Nymphs with wing pads (winged adults), fig. 298.....3

⁷ It is impossible to key to species all nymphs belonging to this genus. Some mature specimens however can be separated with certainty by the characters used here. This is true even of some females which are far enough developed to reveal the shape of the eighth ventral abdominal segment.

ALLOCAPNIA—KEY TO SPECIES—CONCL'D

- Nymphs without conspicuous wing pads (wingless adults), fig. 297.....*vivipara*, p. 370
3. Forewing pad overlapping base of hind wing pad in large nymphs.....4
Forewing pad not overlapping base of hind wing pad in large nymphs....
.....*pygmaea*, p. 367; *granulata*, p. 364; *illinoensis*, p. 365
4. Dorsal lobelike protuberance at apex of abdomen nearly twice as long from base
of cerci to apex as length of ninth dorsal abdominal segment. .*mystica*, p. 366
Dorsal lobelike protuberance at apex of abdomen scarcely longer from base of
cerci to apex than length of ninth dorsal abdominal segment, fig. 291...
.....*recta*, p. 367

***Allocapnia forbesi* Frison**

Figs. 217, 222, 296.

Allocapnia forbesi Frison (1929) p. 397. Original description (♂, ♀).

Very little information concerning this species can be added to that given in the original description. Field studies since 1929 clearly indicate that *forbesi* is restricted in its distribution, fig. 8, to small streams in the Ozarkian uplift region of extreme southern Illinois, that the maximum emergence of the adults occurs during the last of November or first few weeks of December, and that in certain streams the species is abundant. This species has not yet been recorded from any other state.

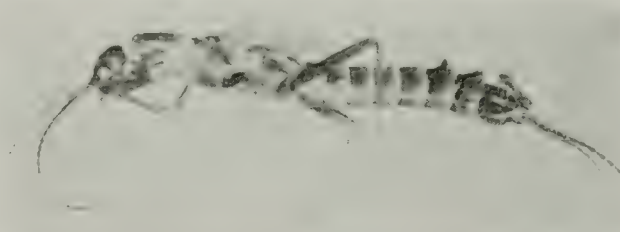


Fig. 296.—LATERAL VIEW OF *Allocapnia forbesi*, ADULT MALE, SHOWING KNOBLIKE PROTUBERANCES ON SEVENTH AND EIGHTH ABDOMINAL SEGMENTS.

Adults.—Cobden: Mar. 4, 1928, 1♂. Dixon Springs: Dec. 7, 1933, 59♂, 5♀. Golconda: Dec. 7, 1933, ♂♂, ♀♀. Herod: Nov. 30, 1928, 44♂, 11♀; Dec. 21, 1930, 1♂; Dec. 7, 1933, 35♂, 7♀. New Columbia: Dec. 26, 1932, ♂♂. Stonefort: Mar. 7, 1928, 3♂.

***Allocapnia forbesi* var. *cornuta* — NEW VARIETY**

The most distinctive feature of the male of *forbesi* is the presence of a large raised tubercle, fig. 222, on the seventh abdominal tergite, about as large as that on the eighth tergite. Two males of *forbesi* have been found which possess on the sixth abdominal tergite a raised tubercle similar to that on the seventh tergite. I am certain that these two males are *forbesi* because of their agreement with all other structural details, association with other *forbesi*, and similarity in structure of raised tubercles on apical tergites. Evidently we are here dealing with a species which is show-

ing a tendency towards further evolution of dorsal abdominal tubercles, something rather characteristic of the *Allocapnia* series. Since this variant might be considered a new species if collected elsewhere as a unique, I am proposing the name of *forbesi* variety *cornuta* for this most interesting form.

Holotype, male.—Dixon Springs, Ill. (Hills Branch cr.): Dec. 7, 1933, collected by T. H. Frison and C. O. Mohr.

Paratype, male.—Herod, Ill. (N. Hicks Branch): Nov. 30, 1928, collected by T. H. Frison and H. H. Ross. Holotype and paratype deposited in the collection of the SURVEY.

Allocapnia granulata (Claassen)

Figs. 220, 227, 289, 294, 295.

Capnella granulata Claassen (1924) p. 44. Original description (♂, ♀).

Allocapnia granulata Frison (1929) p. 394. Nymphal description (♂, ♀).

Except for further distributional records I can add very little to the information concerning this species which I published in 1929. *A. granulata* occurs in all parts of the state but is particularly abundant in the central and northern portions. Contrary to such species as *recta*, *forbesi* and *pygmaea*, the nymphs are found in large rivers as well as in medium sized streams. The adults begin to emerge during the first of January and reach their maximum abundance the latter part of February or in early March. The terminal abdominal segments, not illustrated hitherto, are shown in figs. 220, 227.

This species was first recorded from Illinois (Coles county) by Needham and Claassen (1925). It is also known from the District of Columbia, Maryland and New York. I have compared Illinois specimens with the typic specimens in the collection of Cornell university.

Adults.—Castle Rock: Apr. 3, 1928, 1 ♂, 2 ♀. Charleston: Mar. 9, 1930, 25 ♂, 8 ♀; Mar. 22, 1931, ♂♂, ♀♀. Danville: Jan. 11, 1928, 16 ♂; Mar. 11, 1928, 4 ♂; Feb. 21, 1931, 1 ♂, 1 ♀. Elizabethtown: Mar. 7, 1928, 1 ♀. Georgetown: Mar. 9, 1928, ♂♂, ♀♀. Mahomet: Jan. 15, 1928, 14 ♂. Muncie: Jan. 11, 1928, ♂♂, ♀♀; Feb. 27, 1928, 6 ♂, 4 ♀; Mar. 31, 1928, 4 ♂, 2 ♀. Oakwood: Feb. 24—Mar. 26, 1927, ♂♂, ♀♀; Jan. 7–11, 1928, ♂♂, ♀♀; Feb. 3–27, 1928, ♂♂, ♀♀; Mar. 31, 1928, 10 ♂, 9 ♀; Feb. 24, Mar. 31, 1929, ♂♂, ♀♀; Feb. 2, 1930, ♂♂, ♀♀. Oregon: Apr. 3, 1928, 1 ♂. Oswego: Feb. 11, 1928, 6 ♂. Paris—Chrisman: Mar. 9, 1928, 4 ♀. Pontiac: Mar. 7, 1916, 2 ♀; Mar. 24, 1928, 1 ♂, 7 ♀. Rock Island: Apr. 2, 1928, 3 ♀. Rocky Branch: Jan. 14, 1932, 2 ♂. Towanda: Mar. 24, 1928, 1 ♂, 2 ♀. Union Hill: Mar. 24, 1928, 1 ♂. Urbana: Apr. 3, 1898, 1 ♀; Jan. 16, 1928, 1 ♀. White Heath: Feb. 10, 1929, 1 ♂, 3 ♀. White Heath—Mahomet: Mar. 25, 1928, 6 ♀.

Nymphs.—Oakwood (Salt Fork r.): Jan. 11–12, Feb. 24–26, Mar. 4–10, 1927.

Mating pairs.—Georgetown: Mar. 9, 1928. Oakwood: Feb. 24-26, Mar. 4-10, 1927; Jan. 7-11, Feb. 3, 11, 27, 1928; Feb. 24, Mar. 31, 1929.

***Allocapnia illinoensis* — NEW SPECIES**

Figs. 212, 225.

Male.—Length to apex of wings 3-4 mm.; length to apex of abdomen 6-8 mm. General color dark brown or blackish.

Head slightly wider than thorax. Ocelli arranged to form an isosceles triangle; the anterior ocellus situated well forward on the front, the hind ocelli almost three times as far apart as distance from one ocellus to compound eye. Antennae with 34 segments or thereabouts; basal segment twice as wide as second, succeeding segments gradually becoming less moniliform and more filiform towards apex; length of segments greatest in middle of antennae.

Darkly sclerotized area of pronotum quadrangular, slightly widened at base; angles somewhat rounded, surface with raised rugosities.

Legs almost uniformly dark brown or black; second tarsal joint short, about one-fifth as long as first tarsal segment.

Wings abbreviated, usually extending to sixth or seventh abdominal tergite; hyaline, with veins dark and contrasting.

Abdomen with tergites seven and beyond darker and more heavily sclerotized than those preceding; first five or six tergites with a narrow median pale longitudinal membranous-like stripe. Cerci brown with 16-18 segments; basal segments somewhat moniliform, succeeding segments more filiform. Seventh and eighth dorsal segments with raised knoblike structures, fig. 225. Tubercle on the seventh segment located on the posterior third of the segment, and although rising essentially perpendicular it is slightly inclined posteriorly, and the tip is very slightly notched, fig. 225. Tubercle on eighth segment rising from posterior third of segment and inclined posteriorly at an angle of about 30° ; tip deeply notched, fig. 225. Dorsal segments nine and 10 with a median membranous depression or area for reception of the recurved supra-anal process. Ninth ventral segment rounded behind with apical margin slightly knobbed. Upper part of recurved supra-anal process forming a heavily sclerotized shaft, enlarged at tip, about as long as eighth segment; lower part of process less sclerotized, forming a sheath for reception of dorsal shaft, shaped as in fig. 225.

Female.—Length to apex of wings 6-7 mm.; length to apex of abdomen 6-8 mm.

Head, thorax, abdomen and appendages in general similar to those of the male. Differs from male as follows: wings not abbreviated and extending almost to or beyond tip of abdomen. A wide median dorsal longitudinal strip extending from base of abdomen to hind margin of eighth tergite. Last two abdominal tergites entirely and darkly sclerotized. Apical tergite rounded

behind. Posterior transverse margin of eighth abdominal sternite with a conspicuous sunken or inlaid and somewhat triangularly shaped projection, fig. 212; this inset posteriomedian process in a somewhat membranous area which almost divides the basal part of the sternite into two more or less distinct lateral areas.

Holotype, male.—Dolson (Clarksville), Ill. (fence post near Rocky Branch): Jan. 14, 1932, collected by T. H. Frison and H. H. Ross.

Allotype, female.—Same data as for holotype.

Paratypes.—Same data as for holotype: 7♂, 2♀. Dolson (Clarksville) (Rocky Branch): Mar. 1, 1931, 1♂; Jan. 14, 1932, pair *in coitu*. Dolson (Clarksville) (trib. of Rocky Branch): Jan. 5, 1933, 43♂, 2♀. Dolson (Clarksville) (Big cr.): Jan. 5, 1933, 2♂. Oliver (trib. of Big cr.): Jan. 14, 1932, 4♂. All collected by T. H. Frison and H. H. Ross.

This species was discovered in March 1931, not far from Charleston in a local "pocket" of considerable ecological interest. Each year since then when this particular area has been visited the species has again been found; thereby substantiating from another point of view the conclusion that the morphological differences observed in the adults are true criteria of a distinct species and in this instance a new species.

Nymphs certainly belonging to this species were collected in association with the adults but as in other species of *Allocapnia* possessing well developed wing pads in both sexes, it is impossible to enumerate characters which will invariably serve to identify these nymphs to species. In other words, the nymphs are practically identical with those of *mystica*, *granulata* and most other species of *Allocapnia*.

***Allocapnia mystica* Frison**

Figs. 175, 177, 219, 229, 287.

Allocapnia mystica Frison (1929) p. 399. Original description (adult ♂, ♀; nymphal ♂, ♀).

Collecting since 1929 has added new locality records for this species but has not fundamentally changed the general picture of its range in the state. It is a species of the Ozarkian uplift and more locally of some streams in the upper Wabash watershed. The adults start emerging in November and their maximum abundance is over before February.

Adults.—Carrier Mills: Dec. 1, 1928, 8♂. Dixon Springs: Dec. 7, 1933, 2♂. Eichorn: Nov. 30, 1928, 2♂; Mar. 6, 1928, 1♂, 1♀; Dec. 21, 1930, ♂♂, ♀♀. Fountain Bluff: Feb. 22, 1933, ♂♂, ♀♀. Golconda: Mar. 7, 1928, 1♀; Nov. 30, 1928, 3♂, 1♀; Dec. 7, 1933, ♂♂. Gorham: Feb. 3, 1934, 12♂, 2♀. Grand Detour: Feb. 3, 1934, ♂♂, 4♀. Harrisburg: Mar. 6, 1928, 1♂; Nov. 29, 1928, ♂♂, ♀♀. Herod: Nov. 29–30, 1928, ♂♂, ♀♀; Mar. 6, 1928, 29♀; Dec. 21, 1930, ♂♂, ♀♀; Dec. 7, 1933, ♂♂, ♀♀; Feb. 2, 1934, ♂♂, ♀♀. Marshall: Jan. 3, 1933, ♂♂, ♀♀. Murphysboro: Feb. 22, 1933, ♂♂, ♀♀. New Columbia: Dec. 25–28, 1932, ♂♂, ♀♀. Oakwood: Nov.

18-21, 1928, ♂♂, ♀♀; Dec. 18, 1928, ♂♂, ♀♀; Feb. 24, 1929, 2♀; Jan. 24, 1931, 1♂. Rosiclare: Nov. 30, 1928, 30♂, 3♀. Thebes: Feb. 3, 1934, 2♂, 2♀.

Nymphs.—Harrisburg (Blackman cr.): Nov. 29, 1928. Herod (N. Hicks Branch and Gibbons cr.): Nov. 20, 30, 1928. Marshall (trib. of Big cr.): Jan. 3, 1933. Oakwood (trib. of Salt Fork r.): Nov. 18-21, 1928.

Reared from nymphs.—Grand Tower: Feb. 3, 1934, 1♂. Oakwood: Nov. 21, 1928, 2♂, 3♀.

Mating pairs.—Golconda: Dec. 8, 1933. Herod: Dec. 7, 1933; Feb. 2, 1934. Oakwood: Nov. 18, 21, Dec. 18, 1928.

Since this species has not been recorded from other states, SURVEY collections by H. H. Ross and C. O. Mohr from Missouri are given as follows: Carthage: Nov. 3, 1933, 1♂. Niangua (Webster county): Dec. 4, 1933, 40♂, 40♀. St. Clair—Rolla (Little Bourbois cr.): Jan. 30, 1932, ♂♂, ♀♀.

Allocapnia pygmaea (Burmeister)

Figs. 215, 224.

Semblis pygmaea Burmeister (1839) p. 874. Original description (♂).

Allocapnia pygmaea Frison (1929) p. 396. Nymphal description (♂, ♀).

Except for additional locality records, I have almost nothing to add to my account of 1929. This species is a true member of the winter fauna of the Ozarkian uplift of southern Illinois. Characteristic structures of the terminal abdominal segments of the male, not figured in 1929, are shown here in fig. 215. The species has been recorded previously from Illinois (Frison 1929), the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New York and Virginia.

Adults.—Bloomfield: Mar. 7, 1928, 13♂, 2♀. Dixon Springs: Feb. 2, 1934, ♂♂, 2♀. Eichorn: Mar. 6, 1928, ♂♂, ♀♀. Golconda: Mar. 7, 1928, ♂♂, ♀♀. Gorham: Feb. 3, 1934, 1♂, 1♀. Herod: Mar. 6, 1928, ♂♂, ♀♀. Herod—Elizabethtown: Mar. 6, 1928, 3♂. New Columbia: Dec. 26, 1932, ♂♂. Thebes: Feb. 3, 1934, 4♂. Vienna: Mar. 7, 1928, 1♂.

Nymphs.—Golconda (Big Grand Pierre r.): Mar. 7, 1928.

Mating pairs.—Dixon Springs: Feb. 2, 1934. Herod: Mar. 6, 1928. Golconda: Mar. 7, 1928.

Allocapnia recta (Claassen)

Figs. 213, 221, 290, 291.

Capnella recta Claassen (1924) p. 44. Original description (♂, ♀).

Allocapnia recta Frison (1929) p. 395. Nymphal description (♂, ♀).

In my paper of 1929 this species was recorded only from Oakwood in



Fig. 297.—*Allocapnia vivipara*, NYMPHAL MALE.



Fig. 298.—*Allocapnia vivipara*, NYMPHAL FEMALE.

Illinois and was said to share "with *forbesi* the distinction of being our rarest members of this genus." Additional collecting has revealed this species in another locality not far from Oakwood but it remains extremely localized. Adults begin to emerge in late November and reach a maximum of abundance in December and the early part of January. This species has been recorded to date only from Illinois (Frison 1929), Massachusetts and New York.

Terminal abdominal segments of the male, not illustrated in the previous Illinois report, are shown here in fig. 221. Illinois specimens have been compared with the types of this species in the collection of Cornell university.

Adults.—Dolson: Mar. 1, 1931, ♂♂, ♀♀; Jan. 14, 1932, ♂♂, ♀♀; Jan. 5, 1933, ♂♂, ♀♀. Oakwood: Nov. 28, 1926, ♂♂, ♀♀; Dec. 4, 1926, ♂♂, ♀♀; Feb. 24–26, 1927, 18♂, 4♀; Mar. 4–17, 1927, ♂♂, ♀♀; Nov. 17–27, 1927, ♂♂, ♀♀; Dec. 4, 10, 17, 1927, ♂♂, ♀♀; Jan. 7, 11, 1928, ♂♂, ♀♀; Feb. 3–27, Mar. 11, 1928, 7♂, 23♀; Nov. 18–21, 1928, 24♂, 2♀; Dec. 18, 1928, 33♂, 15♀; Mar. 21, 1929, 1♀.

Nymphs.—Oakwood (trib. of Salt Fork r.): Nov. 28, Dec. 4, 1926; Feb. 24, Mar. 10–17, Nov. 20–23, Dec. 17, 1927; Feb. 11, Nov. 4, 18–21, Dec. 18, 1928.

***Allocapnia vivipara* (Claassen)**

Figs. 57, 87, 117, 144, 218, 228, 257, 292, 293, 297, 298.

Capnella vivipara Claassen (1924) p. 46. Original description (♂, ♀).

Allocapnia vivipara Frison (1929) p. 392. Nymphal description (♂, ♀).

A. vivipara is one of the commonest as well as academically one of the most interesting members of our stonefly fauna. It is generally distributed throughout the state and thrives in small streams as well as along the edges of our largest rivers. Although the adults may be found from December to April, their maximum abundance in most parts of the state is reached during March. Of special interest to the student of stoneflies is the fact that the wings of the male adult are reduced to mere rudiments and in the female wing length varies from brachypterous to macropterous forms. In Illinois the commonest form of the female in the northern counties is brachypterous, and in the southern counties macropterous.

No observations concerning the biology of this species can yet be added to those published by the writer (1929). Terminal abdominal structures of the male are shown in fig. 228.

The original description of *vivipara* was based upon specimens from Lake Forest, Ill. This species has also been recorded from Missouri, New York and Ohio. Walsh in 1862 recorded "*Capnia minima?* Newport"

from the vicinity of Rock Island, Ill. *Capnia* at the time of Walsh was used in a broad sense and included those species now placed in *Allocaḡnia*. Based upon the fact that *Allocaḡnia vivipara* Claassen is the most abundant of the Illinois species, is very common at Rock Island, and that the true *Capnia* in its present restricted sense is a rarity and known only from southern Illinois, I feel that the record of Walsh had best be placed in the synonymy of this species. Further support may be in the fact that the descriptions of *Capnia minima*? available to Walsh referred to a male with rudimentary wings while in the male of *vivipara* the wings are actually represented by the merest rudiments. Needham and Claassen (1925) did not mention this record of Walsh (1862).

Adults.—Barstow: Apr. 2, 1928, ♂♂, ♀♀. Beltrees: Feb. 4, 1934, 5♂. Bloomfield: Mar. 7, 1928, 31♂, 3♀. Bloomington: Mar. 25, 1928, 1♀. Brocton: Mar. 9, 1930, 1♂. Carbondale: Jan. 22, 1928, 3♂; Mar. 4, 1928, ♂♂, ♀♀. Charleston: Mar. 9, 1930, 6♂; Mar. 2, 1931, ♂♂, ♀♀. Choat: Mar. 8, 1928, 1♂. Chrisman: Mar. 9, 1928, 5♂, 9♀. Danville: Jan. 11, 1928, 2♂; Feb. 21, 1931, 1♂, 1♀. Decatur: Mar. 15, 1930, 1♂. Detroit: Jan. 29, 1932, 1♂, 1♀. Dolson: Mar. 1, 1931, 5♂; Jan. 5–6, 1933, ♂♂, ♀♀. Eichorn: Mar. 6, 1928, ♂♂, ♀♀. Elizabethtown: Mar. 7, 1928, 2♀. Evansville: Feb. 3, 1934, 2♂, 1♀. Farmer City: Mar. 25, 1928, 1♀. Fountain Bluff: Feb. 22, 1933, 1♂, 1♀. Ft. Sheridan: Dec. 23, 1927, 7♂, 1♀. Gays: Dec. 30, 1928, 1♂, 2♀. Georgetown: Mar. 9, 1928, 2♂, 1♀. Glenview: Dec. 27, 1927, 2♂. Golconda: Mar. 7, 1928, 12♂, 10♀. Gorham: Feb. 3, 1934, ♂♂, ♀♀. Gossett: Mar. 8, 1928, 9♂, 4♀. Grape Creek: Jan. 17, 1931, 1♀. Grayville: Mar. 8, 1928, ♂♂, 6♀. Harrisburg: Mar. 6, 1928, 1♀. Harrisburg—Stonefort: Mar. 7, 1928, 6♂, 5♀. Herod: Mar. 6, 1928, ♂♂, ♀♀; Dec. 7, 1933, ♂♂, ♀♀. Herod—Elizabethtown: Mar. 6, 1928, 2♂. Hillsboro: Dec. 30, 1928, 6♂. Humboldt: Mar. 11, 1928, ♂♂, ♀♀. Jonesboro: Feb. 3, 1934, ♂♂, ♀♀. Kampsville: Jan. 29, 1932, 1♂. Lexington: Mar. 25, 1928, 1♀. Litchfield: Jan. 3, 1929, 4♂, 2♀. Louisville: Feb. 3, 1928, ♂♂, ♀♀. Mahomet: Jan. 15, 1928, ♂♂, 7♀. Mascoutah: Mar. 3, 1928, 2♀. Mermet: Mar. 7, 1928, 9♂, 3♀. Michael: Jan. 29, 1932, 1♂. Muncie: Mar. 7, 1909, 1♀; Jan. 11, 1928, 1♂, 1♀; Feb. 27, 1928, 1♂, 3♀; Mar. 31, 1928, 1♂, 2♀. Murphysboro: Feb. 22, 1933, ♂♂, ♀♀. New Columbia: Dec. 25–28, 1932, ♂♂, ♀♀. Oakwood: Feb. 24, 1927, 15♂, 5♀; Mar. 4, 10, 17, 26, 1927, ♂♂, ♀♀; Dec. 4–10, 1927, 2♂; Jan. 11, 1928, 1♂; Feb. 3, 27, 1928, 1♂, 2♀; Dec. 18, 1928, ♂♂, ♀♀; Feb. 24, 1929, ♂♂, ♀♀; Jan. 24, 1931, 2♂. Ocoya: Mar. 25, 1928, 1♀. Oliver: Jan. 14, 1932, 4♂. Olmstead: Feb. 2, 1934, ♂♂, ♀♀. Oswego: Feb. 11, 1928, 1♂; Apr. 1, 1928, 1♂. Palos Park: Mar. 15, 1933, ♂♂, ♀♀. Pana: Dec. 30, 1928, 13♂, 5♀. Paris: Mar. 9, 1928, 1♂; Jan. 14, 1932, ♂♂, ♀♀. Paris—Chrisman: Mar. 9, 1928, 1♂, 5♀. Plainview: Jan. 29, 1932, 1♂. Pontiac: Mar. 25, 1928, 1♂. Quincy: Jan. 29, 1932, ♂♂, ♀♀. Reeder: Feb. 3, 1934, 7♂, 2♀. Rock Island: Apr. 2, 1928, 1♀. Rocky Branch: Jan. 14, 1932, ♂♂, ♀♀. Salem: Feb. 21, 1933, 2♂. Shelbyville: Dec. 30, 1928, 1♂, 1♀. Thebes: Feb. 3, 1934, 2♂. Texas City: Mar. 8, 1928, ♂♂, 9♀. Towanda: Mar. 25, 1928, 5♀. Urbana: Jan. 16, 1928, ♂♂, ♀♀. Vienna: Mar. 7, 1928, ♂♂, ♀♀. Vienna—Mermet: Mar. 8, 1928, 3♂, 17♀. Walnut Prairie: Mar. 8, 1928, 1♀, 1♀. Watson: Apr. 7, 1932, 1♀; Jan. 8, 1933, ♂♂, ♀♀. Westfield: Feb.

14, 1932, ♂♂, ♀♀. Winchester: Jan. 29, 1932, 1♂, 1♀. Winthrop Harbor: Mar. 16, 1933, ♂♂, ♀♀. White Heath—Mahomet: Mar. 25, 1928, 1♂. W. York: Mar. 8, 1928, 13♂, 13♀.

Nymphs.—Barstow (trib. of Rock r.): Apr. 2, 1928. Carbondale (trib. of Crab Orchard cr.): Mar. 4, 1928, exuviae. Cobden (Clay Lick cr.): Dec. 1, 1928. Cora: Dec. 8, 1933; Feb. 3, 1934. Danville (North Fork): Jan. 11, Nov. 22, 1928. Detroit (Duff cr.): Jan. 29, 1932. Dolson (Big cr.): Jan. 5, 1933. Effingham (Little Wabash r.): Mar. 25, 1932. Ft. Sheridan: Dec. 23, 1927. Funkhouser: Dec. 2, 1928. Glenview: Dec. 27, 1927. Grand Tower: Feb. 3, 1934. Harrisburg (Blackman cr.): Nov. 29, 1928. Herod (N. Hicks cr.): Nov. 30, 1928. Mahomet (Sangamon r.): Jan. 15, Nov. 22, Dec. 9, 1928. Marseilles (N. Kickapoo cr., Walbridge cr.): Nov. 23, 1928. Michael: Jan. 29, 1932. Muncie (Stony cr.): Dec. 4, 1926; Feb. 27, Mar. 31, Dec. 23, 1928. Oakwood (Salt Fork r. and tribs.): Nov. 28, Dec. 4, 1926; Mar. 4–10, Nov. 23, 1927; Feb. 11, Mar. 31, Nov. 18–22, Dec. 18, 1928. Oliver (trib. of Big cr.): Jan. 14, 1932. Pana: Dec. 30, 1928. Paris: Jan. 14, 1932. Payson (Burton cr.): Jan. 29, 1932. Quincy (Mill cr.): Jan. 29, 1932. Shelbyville (Kaskaskia r.): Dec. 30, 1928. Starved Rock (trib. of Illinois r.): Nov. 23, 1928.

Mating pairs.—Carbondale: Mar. 4, 1928. Grayville: Mar. 8, 1927. Mahomet: Jan. 15, 1928. Oakwood: Mar. 4, 10, 1927; Dec. 18, 1928. Paris: Jan. 14, 1932. W. York: Mar. 8, 1928.

PERLIDAE

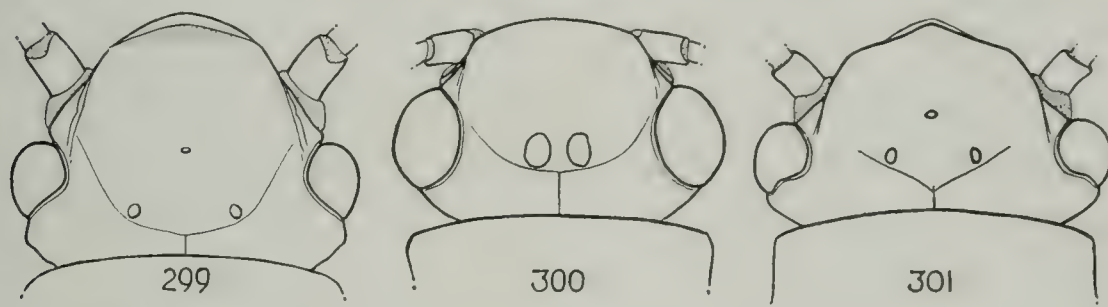
The family Perlidae, as here used, differs from the Perlidae of previous American writers (Needham and Claassen 1925) by the transfer of several genera to the families Chloroperlidae and Perlodidae. My reasons for restricting the number of genera in this family have been given in speaking of the classification proposed by this paper, p. 308.

In Illinois we find seven groups or assemblages of morphologically distinct species, constituting the genera *Atoperla*, *Perlinella*, *Neoperla*, *Perlesta*, *Acroneuria*, *Neophasganophora* and *Togoperla*, which I consider as belonging to the family Perlidae in its strictest sense.

Two of these genera, *Neophasganophora* and *Togoperla*, were included in the genus *Perla* by Needham and Claassen (1925) together with other species which I recognize as genera and place in the families of Chloroperlidae and Perlodidae. The genus *Perla* as used by Needham and Claassen (1925) is, as these authors have frankly stated, "a somewhat heterogeneous group of mostly rather large stoneflies having little else in common than the dorsally cleft tenth segment of the male abdomen."

When writing of the nymphs Claassen (1931) refers again to the unnaturalness of *Perla* as used by Needham and Claassen (1925), when he states "it is evident that some changes will have to be made as soon as the immature stages of the various species are better known, especially

in the genus *Perla*, in order to arrange the species in more natural groups." It is incompatible with the varied knowledge now available concerning the adults and nymphs of our Illinois stoneflies and defeats one of the purposes of taxonomy longer to accept as a generic unit such a heterogeneous assemblage of unrelated species as have been placed in *Perla* by American authors. Although Needham and Claassen (1925) have placed several species of *Perla* (in the broad sense as used by them) in the subgenus *Perla* Geoffroy (*s. str.*) it is even doubtful whether the true *Perla* in the restricted sense as used by Klapalek (1923) occurs in North America.



Figs. 299-301.—DORSAL VIEW OF HEAD OF PERLID ADULTS, SHOWING DIFFERENCE IN NUMBERS AND ARRANGEMENT OF OCELLI. 299.—*Perlinella drymo*, female. 300.—*Neoperla clymene*, female. 301.—*Acroneuria abnormis*, female.

The genera composing the family Perlidae, with the exception of *Acroneuria* which may eventually be shown to be a composite of several related groups, are essentially genera of the states east of the Rocky mountains. The adults range from medium to large and are more frequently collected by the general entomologist than are those of other families. The adults of this family are very definitely associated with the late spring and summer fauna, in marked contrast with the Taeniopterygidae and Capniidae which appear during the colder months. The nymphs are essentially carnivorous and the adults take little or no food.

KEY TO GENERA

Adults

1. Ninth ventral abdominal segment much produced posteriorly and recurved upward so that tenth ventral abdominal segment is mostly or entirely concealed, fig. 302. Some species with a disklike structure in middle of posterior portion of ninth ventral abdominal segment, fig. 302. Eighth ventral abdominal segment never notched in middle of posterior margin or produced over ninth ventral abdominal segment, fig. 302, (males)... 2
- Ninth ventral abdominal segment poorly or not at all produced posteriorly, fig. 247; tenth ventral abdominal segment always visible. Eighth ventral abdominal segment notched in middle of posterior margin, figs. 243, 254, or with a subgenital plate, fig. 248, partly projecting over ninth segment (females)... 8

PERLIDAE—KEY TO GENERA—CONT'D

2. Median ocellus lacking or so poorly developed that only lateral ocelli are clearly visible, fig. 300; head therefore appearing to have but two ocelli.3
 Median ocellus well developed, fig. 301; head therefore clearly with three ocelli.4
3. Lateral ocelli close together, much closer to one another than each lateral ocellus is removed from compound eye. Forewing without crossveins in anal field and with many crossveins before subcosta, fig. 181. Ninth ventral abdominal segment without a disklike structure in middle of posterior portion.**Neoperla**, p. 381

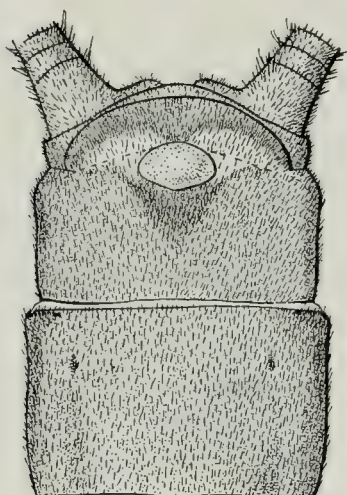


Fig. 302. — VENTRAL VIEW OF TERMINAL ABDOMINAL SEGMENTS OF *Acro-neuria ruralis*, ADULT MALE, SHOWING PADLIKE DISK ON NINTH STERNITE.

- Lateral ocelli far apart, at least as far removed from one another as each lateral ocellus is removed from compound eye. Forewing with crossveins in anal field and few if any crossveins before subcosta, fig. 179. Ninth ventral abdominal segment with a disklike structure in middle of posterior portion.**Atoperla**, p. 377
4. Ninth ventral abdominal segment with a disklike structure in middle of posterior portion, fig. 302.7
 Ninth ventral abdominal segment without a disklike structure in middle of posterior portion.5
5. Fifth dorsal abdominal segment much different from preceding segments, enlarged and prolonged backwards, figs. 206, 207. Tenth dorsal abdominal segment divided in middle and with a pair of genital hooks directed forward, figs. 206, 207.6
 Fifth dorsal abdominal segment similar to preceding segments. Tenth dorsal abdominal segment undivided and without genital hooks, fig. 202.**Perlesta**, p. 384
6. Genital hooks on tenth dorsal abdominal segment short, fig. 206.
 **Togoperla**, p. 412
 Genital hooks on tenth dorsal abdominal segment very long, fig. 207.
 **Neophasganophora**, p. 407
7. Forewings with few or no crossveins in costal cell and several crossveins between first and second anal veins, fig. 180. Compound eyes set forward on side of head about their diameter distant from hind margin of head, fig. 299. Prothorax with sides and a median longitudinal stripe of black or brown; area between yellow.**Perlinella**, p. 380
 Forewings with crossveins numerous in costal cell and usually no crossveins (rarely one) between anal veins of forewing, fig. 182. Compound eyes set back on side of head near hind margin, fig. 301. Prothorax essentially brown with scattered interrupted lighter markings.**Acro-neuria**, p. 388
8. Median ocellus lacking or so poorly developed that only lateral ocelli are visible, fig. 300; head therefore appearing to have only two ocelli.9
 Median ocellus well developed, fig. 301; head therefore clearly with three ocelli.10

PERLIDAE—KEY TO GENERA—CONT'D

9. Lateral ocelli close together, much closer to one another than each lateral ocellus is removed from compound eye. Forewing without crossveins in anal field and with many crossveins in costal cell, fig. 181. Eighth ventral abdominal segment as in fig. 245.....**Neoperla**, p. 381
 Lateral ocelli far apart, at least as far removed from one another as each lateral ocellus is removed from compound eye. Forewing with crossveins in anal field and with few if any crossveins in costal cell, fig. 179. Eighth ventral abdominal segment as in fig. 240.....**Atoperla**, p. 377
10. Forewing with few or no crossveins in costal cell and several crossveins between first and second anal veins, fig. 180.....**Perlinella**, p. 380
 Forewing with numerous crossveins in costal cell and usually no crossveins (rarely one) between first and second anal veins, fig. 182.....11
11. Costal margin of forewing and base of Rs and M yellowish, contrasting with brownish veins.....12
 Costal margin of forewing dark and almost unicolorous with rest of wing...13
12. Eighth ventral abdominal segment with a well developed subgenital plate and shaped as in fig. 252.....**Neophasganophora**, p. 407
 Eighth ventral abdominal segment without a well developed subgenital plate and shaped as in fig. 241.....**Perlesta**, p. 384
13. Forewing with at least one crossvein, usually more, beyond the cord in apical portion of wing in addition to those in subcostal cell, fig. 182. Eighth ventral abdominal segment in some species with a well developed subgenital plate, figs. 243, 247, and in others with the subgenital plate less developed, figs. 244, 248.....**Acroneuria**, p. 388
 Forewing usually with no crossvein (rarely one) beyond the cord in apical portion of wing in addition to those in subcostal cell. Eighth ventral abdominal segment without a well developed subgenital plate, fig. 254.
**Togoperla**, p. 412

Nymphs

1. Compound eyes situated far forward on side of head and considerably removed from posterior margin, figs. 303, 304.....2
 Compound eyes situated well back on side of head and close to posterior margin, fig. 317.....3
2. Anterior ocellus absent, fig. 303. Nymphs small, not exceeding 12 mm. when full grown. Almost uniform light brown.....**Atoperla**, p. 377
 Anterior ocellus present in half grown to full grown adults, fig. 304, but inconspicuous in small nymphs. Nymphs of medium size, up to 20 mm. or more when full grown. Dorsum of head, thorax and abdomen with a discernible pattern of contrasting areas of light and dark brown.....
**Perlinella**, p. 380
3. Anterior ocellus absent, fig. 305. Distinct transverse occipital ridge back of lateral ocelli.....**Neoperla**, p. 381
 Anterior ocellus present, fig. 307. With or without distinct transverse occipital ridge.....4
4. Dorsum of abdomen with conspicuous freckle-like spots on a uniform dark background, fig. 307. Transverse occipital ridge present. Anal gills present.
**Perlesta**, p. 384

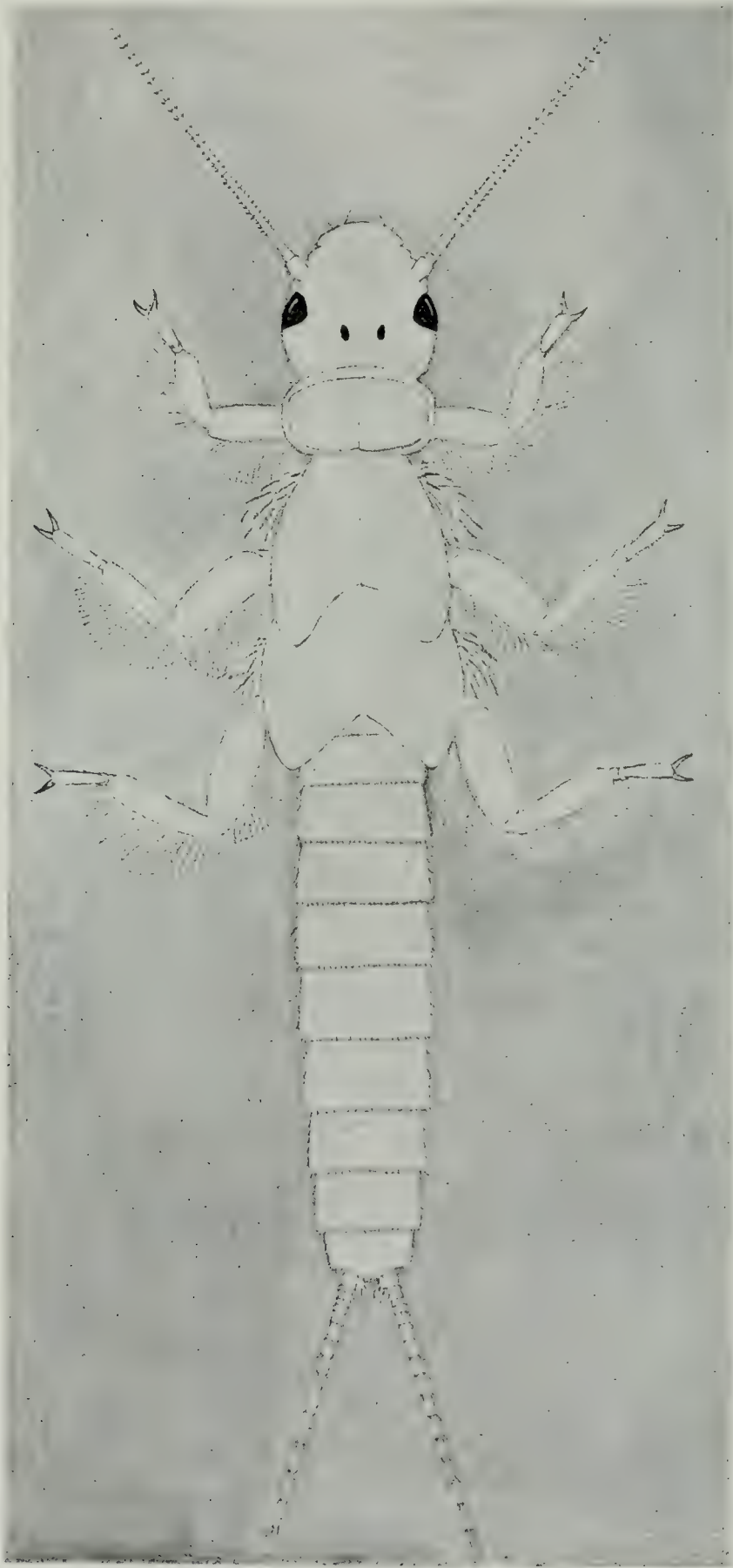


Fig. 303.—*Atoperla ephyre*, NYMPHAL FEMALE.

PERLIDAE—KEY TO GENERA—CONCL'D

- Dorsum of abdomen without freckle-like spots, figs. 316, 318. With or without transverse occipital ridge. With or without anal gills.....5
5. Transverse occipital ridge present, fig. 318.....6
Transverse occipital ridge absent, fig. 314.....*Acroneuria* in part, p. 388
6. Anal gills present, fig. 318. Dorsum of abdomen with conspicuous alternating light and dark transverse areas or bands.....*Neophasganophora*, p. 407
Anal gills absent, fig. 314. Dorsum of abdomen without conspicuous alternating light and dark transverse areas or bands.....7
7. Dorsum of head, thorax and abdomen nearly uniform light brown. Lateral ocelli ahead of the transverse occipital ridge a distance about equal to the distance between them, fig. 315.....*Acroneuria* in part, p. 388
Dorsum of head and thorax with some light areas distinct from brown background. Lateral ocelli ahead of the transverse occipital ridge a distance about or less than one-half the distance between them, fig. 321.....
.....*Togoperla*, p. 412

Atoperla Banks

Banks (1905) p. 56. Genotype *Perla producta* Walsh = *Atoperla ephyre* (Newman), original designation; monotypic.

This genus contains but one small species which shows many characters in common with *Perlinella*. Claassen (1931) states that "In general appearance *Atoperla* is similar to *Perlinella* but is smaller in size and has no anal gills." This statement about absence of anal gills is probably due to the "old and shriveled specimens" upon which description of the nymph was based, for fresh specimens show traces of these anal gills.

Atoperla ephyre (Newman)

Figs. 30, 60, 90, 120, 146, 179, 200, 240, 303.

Perla ephyre Newman (1839) p. 87. Original description.

Atoperla ephyre Claassen (1931) p. 78. Nymphal description.

This species was first recorded from Illinois by Walsh (1862) under two names, *Perla producta* Walsh and *Perla fumipennis* Walsh, and later by Claassen (1931) as *Atoperla ephyre*. The material of Walsh was collected at Rock Island and Chicago and the nymphs recorded by Claassen came from the Fox river, Ottawa, Ill. Other references to this species in Illinois are based upon the records of Walsh and add nothing new. In addition to the Illinois records *ephyre* has been recorded from Arkansas, Kansas, Massachusetts, New York, North Carolina and Pennsylvania, records which indicate that this species is to be expected in most states east of the Rocky mountains.

Types of *producta* Walsh exist in the collection of the Museum of Comparative Zoology, Cambridge, Mass. The types of *fumipennis* are

apparently no longer in existence. I accept the placing by Needham and Claassen (1925) of this latter name in the synonymy of *ephyre* upon the basis of comparisons of Illinois material with the original description and our intimate knowledge of the Illinois fauna which does not indicate the existence of another species closely allied to *ephyre*. The characters mentioned by Walsh in his original description fall within the range of the color variation of this species. The NATURAL HISTORY SURVEY collection contains one female specimen of *ephyre* from "N. Ill." which was determined as *Perla producta* Walsh by Walsh.

Judging from records in literature and our field observations this species is never exceedingly abundant. Our Illinois material comes mostly from the Rock river valley and specimens have never been collected in the southern part of the state. It is further evident from our field work that the nymphs frequent medium to large sized, clean streams where the bottom is rocky or gravelly and the current rather fast. The nymphs, judging by their mouthparts and the habits of other genera in this family, are carnivorous. Specimens of the nymphs have not been dissected to establish this point because of the scarcity of our nymphal material. The adults are nocturnal and may be collected at lights, or during the day while they are resting upon structures near the places at which the nymphs leave the water to emerge at night. The seasonal appearance of the adults is such as to place this species as a member of the late spring and early summer fauna.

The nymph has already been adequately described by Claassen (1931) and the adults of both sexes by previous students of this group. The description of the nymph by Claassen (1931), however, is erroneous in regard to the statement about the absence of anal gills. The anal gills, although feebly developed, are present and discernible in fresh material. The specimens available to Claassen at the time of his paper were "old and shriveled" and undoubtedly had the anal gills broken off or so withdrawn within the anal segment that they were not visible. Characters developed in the preceding key to the genera bring out the most typical features of this species and genus, and the general appearance is shown by fig. 303.

Adults.—Galena: June 1, 1933, 1♀. Oakwood: July 6, 1927, 1♂, 1♀; June 17, 1928, 1♀; May 24, 1931, 1♂. Oregon: July 18, 1921, 2♀. Rockford: June 13, 1931, 2♀. Rock Island: June 3, 1930, 1♂; June 5, 8, 13, 1931, 1♂, 5♀. The adults from Oakwood were collected along the shore of the Salt Fork river where the bed is rocky and the current fast.

Nymphs.—Byron: May 23, 1927. Grand Detour: May 29, 1927. Rockford: June 13, 1931, exuviae. Rock Island: July 7, 1929, exuvia. Sterling—Dixon: June 8, 1927. All nymphal material from the Rock river.



Fig. 304.—*Perlinella drymo*, NYMPHAL FEMALE.

Perlinella Banks

Banks (1900) p. 242. Genotype *Perla trivittata* Banks = *Perlinella drymo* (Newman), original designation; monotypic.

Like the closely related genus *Atoperla*, this genus contains but one known species, *drymo* (Newman).

Perlinella drymo (Newman)

Figs. 31, 61, 91, 121, 154, 180, 201, 253, 265, 299, 304.

Perla drymo Newman (1839) p. 86. Original description.

Perlinella drymo Claassen (1931) p. 79. Nymphal description.

Perlinella drymo was first recorded from Rock Island, Ill. by Walsh (1862), under the name of *Perla elongata* Walsh. It was next recorded from Lake Forest, Ill. by Claassen (1931).

Our field observations and records in literature are rather indicative that this species, although widely distributed, is never very abundant. Needham and Claassen (1925) state that it is distributed "east of the Mississippi river" and records in literature in addition to this state are for Georgia (typic locality), Indiana, Maine, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Nova Scotia and Tennessee. Our Illinois records are so generally scattered over the state it is safe to predict that future collecting in many other states in the Mississippi drainage area will reveal the presence of this stonefly.

The adults are diurnal and are most frequently caught while resting on bridges, trees or other objects situated near streams which harbor the nymphs. Our records for the adults indicate that they begin to emerge the latter part of March and reach their maximum abundance in April. Thus, on the basis of the seasonal appearance of the adults this species may be classified as a spring form.

Although no types of *elongata* are known to exist I do not question the placement of *elongata* in the synonymy of *drymo* as is done by Needham and Claassen (1925). The description of *elongata* by Walsh states "Differs from the preceding (*P. fumipennis* = *A. ephyre*) only in the ocelli being three in number." This statement, together with his other descriptive remarks, clearly indicates the relationship of *elongata* with *ephyre*, which is a condition already noted. Furthermore, *P. drymo* occurs at Rock Island as proved by our collection there of the immature forms.

The nymphs of this species are quite conspicuous because of their long, branched, copious gills, fig. 265. The only place I have found them common was in the Big Grand Pierre river near Golconda on March 7, 1928. Upon this occasion the nymphs were collected in numbers on a

gravelly sand bar but slightly covered with water. They were lodged under and between small stones where the current was swift and debris had accumulated. The dissection of one of these nymphs has revealed many head capsules of chironomid nymphs, thus proving that they are carnivorous.

The nymph has been described by Claassen (1931); however the most important morphological features of adults and nymphs are given here in figs. 31, 61, 91, 121, 154, 201, 253.

Adults.—Alto Pass: Apr. 8, 1928, 1♂. Havana: Apr. 21–23, 1898, 3♂, 3♀. Homer: Apr. 28, 1929, 1♀. Mahomet: Apr. 23, 1925, 1♂. Metropolis: Mar. 28, 1932, 1♀.

Nymphs.—Golconda (Big Grand Pierre r.): Mar. 7, 1928. Havana (Illinois r.): Apr. 23, 1898, exuviae. Herod (trib. of N. Hicks Branch): Dec. 21, 1930. Homer (Salt Fork r.): Apr. 20, 1928. Hutsonville (Wabash r.): Nov. 29, 1928. Rock Island (Rock r.): Apr. 2, 1928. Sterling (Rock r.): May 13, 1925.

Neoperla Needham

Pseudoperla MacGillivray, in Banks (1892) p. 372. Preoccupied. No genotype given.

Neoperla Needham (1905) p. 108. New name. Genotype *Perla occipitalis* Pictet = *Neoperla clymene* (Newman), original designation.

According to Klapalek (1923) members of this genus occur in Africa, Asia, the East Indies and North America. The same author lists three species, *clymene* (Newman), *occipitalis* (Pictet) and *fumipennis* (Walsh), as belonging to this genus in North America. I agree with Needham and Claassen (1925) in considering *occipitalis* and *clymene* to be the same and that *fumipennis*, as stated elsewhere, belongs in the synonymy of *Atoperla ephyre*. Therefore, *Neoperla* in North America is represented by a single species, *clymene* (Newman).

Neoperla clymene (Newman)

Figs. 32, 62, 92, 122, 164, 181, 203, 245, 261, 300, 305, 306.

Chloroperla clymene Newman (1839) p. 87. Original description.

Neoperla clymene Claassen (1931) p. 67. Nymphal description.

Walsh (1862) under the name of "*Perla occipitalis?* Pict.," first recorded this species from near Rock Island, Ill. The next Illinois records for this species are those of Needham and Claassen (1925). Our Illinois records are from widely scattered localities and sufficient to indicate that it is liable to be found in every county. To date *clymene* has been recorded from many of the states east of the Rocky mountains. It enjoys with *Perlesta placida* (Hagen) the distinction of having its distribution the best known of the North American stoneflies.

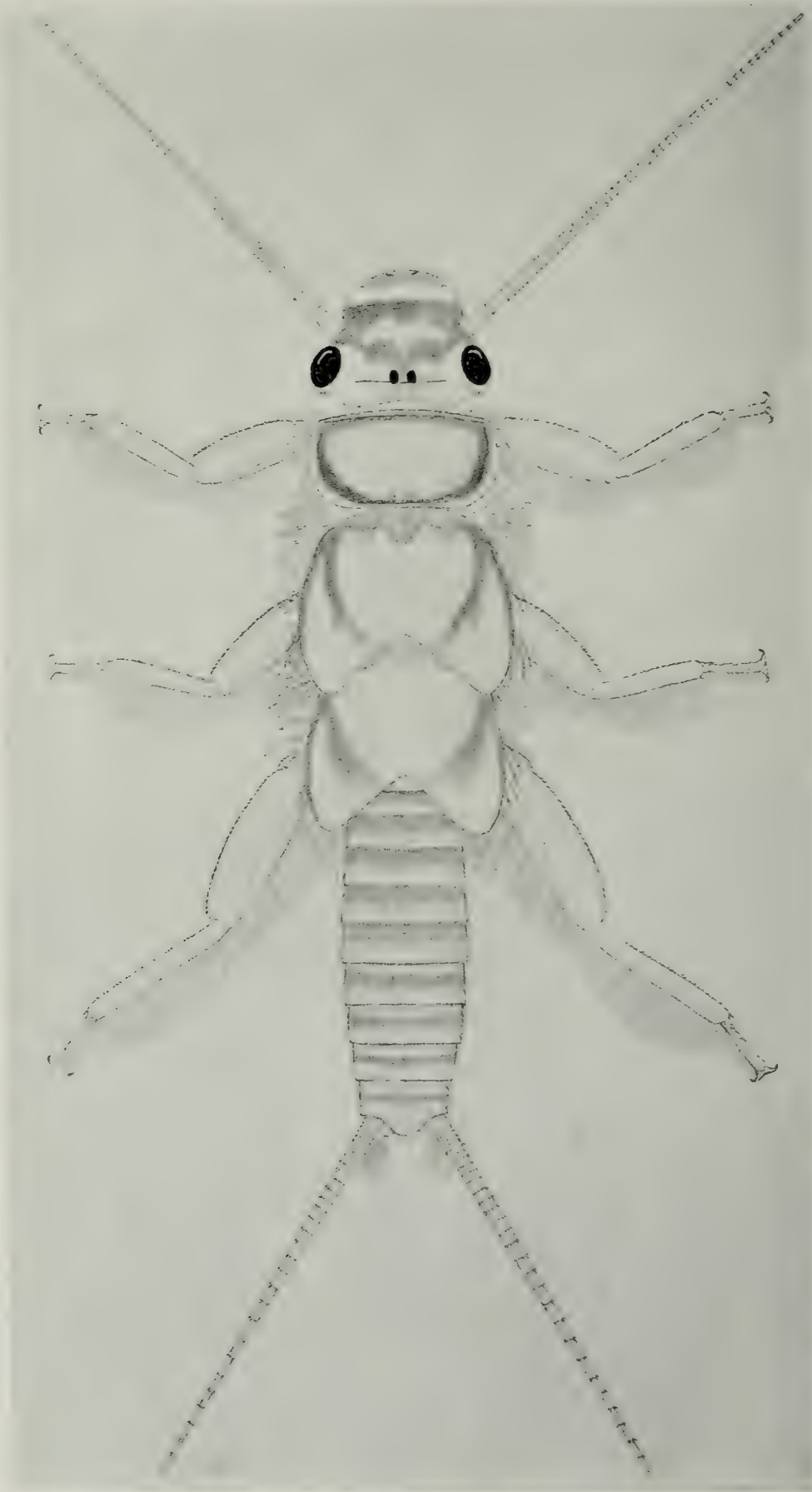


Fig. 305.—*Neoperla clymene*, NYMPHAL FEMALE, LIGHT FORM.



Fig. 306.—*Neoperla clymene*, NYMPHAL FEMALE, DARK FORM.

The nymphs, described by Claassen (1931), are readily separated from most species because they possess only two ocelli. Important morphological features of adults are shown in figs. 203, 245, and of the nymphs in figs. 32, 62, 92, 122, 164, 181, 300.

The alimentary tract of a dissected nymph was found to be full of insect remains, particularly the head capsules of chironomid larvae. This confirms the statement of Claassen (1931) that the nymphs are carnivorous. They live in small as well as large streams and are often found associated with *Perlesta placida* in vegetative growth on small stones or other objects submerged in rapid parts of the stream.

The adults are nocturnal and may be collected at lights or during the day by sweeping vegetation near streams. They begin to emerge in Illinois about the middle of June, reach their maximum abundance in early July and a few can still be collected in late August—making them a true summer species.

Adults.—Cairo: June 29, 1909, 1♀. [Champaign: July 31, 1889, 1♂. Elizabethtown: June 20, 1929, 1♀; June 25, 1932, 1♂. Herod: June 21, 1929, 1♀. Homer (park): June 30, 1927, 15♂, 33♀; July 11, 1927, 2♂, 6♀. Mt. Carmel: June 10, 11, 1890, 2♂; June 30, 1906, 1♂, 3♀. Muncie: July 6, 1907, 1♀; July 27, 1927, 1♂, 1♀; Aug. 21, 1927, 2♀. Oakwood: July 6, 1925, 2♀; June 18, 1926, 1♂, 3♀; July 6, 1927, 14♂, 22♀; July 8, 1928, 1♀; June 14, 1930, 2♂, 1♀. Pike: June 25, 1906, 1♀. Rock Island: June 13, 1931, 1♂. Savanna: July 20, 1927, 1♀. Urbana: 1♀; Aug. 11, 17, 1892, 1♂, 1♀; June 17, 1929, 2♂.

Nymphs.—Como (Elkhorn cr.): June 18, 1925. Como—Lyndon (Rock r.): Aug. 5, 1924. Goodfield (Mackinaw r.): June 16, 1931, exuviae. Golconda (Ohio r.): Apr. 17, 1930. Herod (N. Hicks Branch): June 21, 1929. Keithsburg (Mississippi r.): June 9, 1932. Lyndon (Rock r.): July 8, 1925. Mt. Carmel (Wabash r.): Apr. 2, 1932. Rock Island (Rock r.): July 6–7, 1929; June 8, 1931.

Reared from nymphs.—Oakwood (Salt Fork r.): June 29, 1929.

Mating pair.—Oakwood: June 22, 1930.

Perlesta Banks

Banks (1906b) p. 222. Genotype *Perla placida* Hagen = *Perlesta placida* (Hagen), original designation.

This genus is now considered as having only one species, *placida* (Hagen). When originally proposed it was thought to contain more species (*cinctipes* Banks and *virginica* Banks) but Needham and Claassen (1925) have concluded that these forms represent a single species. Our observations in Illinois and several adjacent states tend to confirm the conclusion that but one species of *Perlesta* exists or has been described to date.



Fig. 307.—*Perlesta placida*, NYMPHAL MALE.

Perlesta placida (Hagen)

Figs. 22, 33, 63, 93, 123, 149, 202, 241, 307, 308.

Perla placida Hagen (1861) p. 28. Original description.*Perlesta placida* Claassen (1931) p. 76. Nymphal description.

This species, like *Neoperla clymene* (Newman), has been recorded from many of the states east of the Rocky mountains and is likely to be found in most of the others. It was first recorded from Illinois, near Rock Island, by Walsh (1862) under the name "*Perla decipiens*, n. sp." and also as "*Chloroperla brunnipennis*, n. sp." According to Needham and Claassen (1925), *decipiens* Walsh and *brunnipennis* Walsh are synonyms of *placida* (Hagen) and I am accepting this synonymy. Typic specimens of *decipiens* and *brunnipennis* are in the Museum of Comparative Zoology, Cambridge, Mass. In our collection there is one specimen of *placida* (Hagen) which has been named as *decipiens* by Walsh. In addition to the record by Walsh, this species has been recorded from Lake Forest and W. Ottawa, Ill. by Claassen (1931).

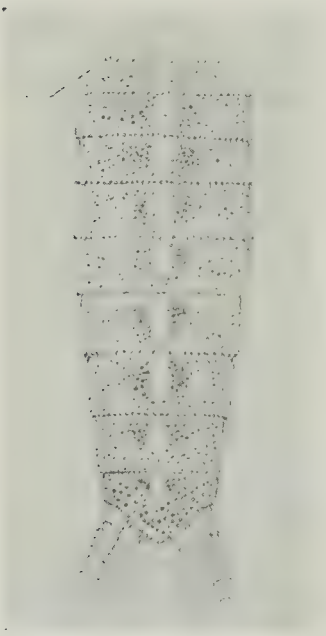


Fig. 308.—DORSAL ABDOMINAL SEGMENTS OF *Perlesta placida*, NYMPHAL MALE, EXTREME SPECKLED FORM.

The adults are nocturnal and swarm to lights near rivers. During the day the adults rest upon vegetation or other objects near streams and may be captured in numbers by sweeping the vegetation with a net. They begin to emerge the latter part of May, reach their maximum abundance during the first weeks of July, and have practically disappeared by the end of August. Their seasonal range is such that they are a true member of the summer fauna. We have collected the nymphs or adults of *placida* in most of the counties of Illinois, fig. 6, and they are so abundant in all parts as to be exceeded here only by a few of the winter stoneflies such as *Allocapnia vivipara* and *Taeniopteryx nivalis*.

As Claassen (1931) has stated, the nymphs are carnivorous. Upon several occasions I have collected nymphs which were then engaged in making a meal of a chironomid nymph. The alimentary tract of a specimen collected at Oregon, Ill. on July 11, 1929 was full of insect remains, particularly of chironomid larvae. The adults have not been observed feeding.

Nymphs may be obtained in numbers from the vegetation growing on small stones in the rapid parts of streams, under stones, or where debris

lodges. Clean streams and those carrying a heavy load of silt are equally productive. Apparently little preference for stream size is shown either, except that the nymphs do not occur in many small streams that are productive of *Allocapnia*. This is probably due to the fact that *Perlesta* nymphs develop at a time of year when many small streams which are inhabited by *Allocapnia* are very largely dry.

Although records of birds using adult stoneflies as food are rare I feel certain that these insects as a food supply are not altogether overlooked. Upon one occasion near Oregon, Ill. when *placida* was exceedingly abundant, I saw a robin catch and eat an adult of this stonefly.

The nymphs are easily recognized because of their freckled or spotted appearance, fig. 308. Claassen (1931) has described the nymph, based upon association of nymphs and adults, and my rearings prove this correlation to be correct. The important morphological features of the adults and nymphs are given here in figs. 33, 63, 93, 123, 149, 202, 241.

Adults.—Algonquin: June 25, 1905, 1 ♂; July 17–24, 1905, 4 ♀; July 4, 16, 1906, 1 ♂, 1 ♀; July 4, 1907, 1 ♀; July 21, 1908, 1 ♀; July 9, 1909, 3 ♀; July 1, 1910, 1 ♂; July 23, 1927, 5 ♂, 1 ♀. Alton: July 21, 1932, 1 ♀. Aurora: July 9, 1925, 9 ♀; June 15, 1910, 1 ♂, 1 ♀; July 17, 1927, 2 ♂, 103 ♀. Beardstown: June 25, 1931, 1 ♀. Blue Island: June 6, 1912, 1 ♂, 1 ♀. Byron: July 11, 1927, 1 ♀. Champaign: June 9, 14, 1888, 1 ♂, 1 ♀; July 2, 1892, 1 ♀. Charleston: June 7–19, 1931, 13 ♂, 5 ♀. Clay City: June 24, 1909, 3 ♂. Dubois: July 2, 1909, 1 ♀. Duncan Mills: July 10, 1896, 1 ♀. E. Dubuque: July 21, 1927, 1 ♂, 3 ♀. Effingham: June 20, 1927, 2 ♀; June 17, 1929, ♂♂, ♀♀. Elizabethtown: May 31, 1932, 1 ♂, 1 ♀; June 22–24, 1932, ♂♂, ♀♀. Florence: June 7, 1928, 8 ♂, 5 ♀. Fountain Bluff: July 25, 1905, 1 ♂. Frankfort: June 8, 1933, 1 ♂, 1 ♀. Fulton: July 20, 1927, 2 ♀. Grand Tower: Aug. 8, 1891, 1 ♂; June 30, 1909, 1 ♀; July 12, 1909, 1 ♀; July 2, 1932, 1 ♀. Hardin: June 25, 1931, 1 ♂. Havana: May 31, 1894, 1 ♀; June 21–25, 1898, 2 ♂, 2 ♀; June 19, 1909, 1 ♀; Aug. 22, 1910, 1 ♀. Homer: June 17, 1917, 1 ♂; July 19, 1924, ♂♂, ♀♀; June 30, 1925, 3 ♂, 1 ♀; June 30, 1927, ♂♂, ♀♀; July 6–11, 1927, ♂♂, ♀♀; June 14–17, 1930, 4 ♂, 4 ♀; June 1–11, 1931, ♂♂, ♀♀; July 25, 1931, 1 ♀. Kampsville: June 25, 1931, 2 ♂, 1 ♀. Kankakee: June 29, 1928, 1 ♂, 1 ♀; June 12, 1931, 1 ♂; June 5, 1932, 1 ♂. Makanda: May 21, 1932, 1 ♂, 1 ♀. McHenry: June 30, 1931, 2 ♂, 3 ♀. Momence: June 4, 1932, ♂♂, ♀♀. Monticello: June 21, 1914, 1 ♀; June 1932, 2 ♀. Mounds: May 25, 1932, 1 ♀. Muncie: June 13, 1905, 1 ♀; June 23, 1912, 2 ♀; June 10, 1919, 1 ♀; June 8, 1927, ♂♂, ♀♀; July 27, 1927, 4 ♀; Aug. 21, 1927, 1 ♂; July 9, 1931, 1 ♀. New Milford: July 21, 1931, 1 ♂, 1 ♀. Oakwood: June 6, 1925, 1 ♂, 2 ♀; May 30, 1926, 1 ♀; June 9, 18, 1926, 19 ♂, 13 ♀; June 2, 1927, 1 ♂, 1 ♀; July 6, 10, 1927, 156 ♂, 126 ♀; June 17, 1928, 11 ♂, 23 ♀; July 28, 1929, 2 ♀; May 24, 1930, 1 ♂; June 14, 1930, 3 ♂, 8 ♀. Odin: June 2, 1909, 1 ♂. Oregon: July 9, 1925, 2 ♂, 10 ♀; July 18, 1927, ♂♂, ♀♀; July 18–19, 1927, 90 ♂, 105 ♀; May 21–June 15, 1928, 3 ♂, 6 ♀; June 27–28, 1928, 4 ♂, 2 ♀; July 11, 1929, ♂♂, ♀♀; June 1930, 6 ♂, 16 ♀; June 13, 1931, 1 ♀; July 3, 1932, 1 ♀. Ottawa: June 12, 1901, 3 ♂, 1 ♀. Ozark: May 18, 1932, ♀♀. Pike: June 25, 1906, 1 ♂. Prophetstown: July 19, 1927,

4♂, 1♀. Pulaski: June 10, 1907, 1♀; May 11, 1932, ♂♂, ♀♀. Putnam: July 12, 1933, 1♂. Rockford: July 18, 1927, 72♂, 87♀; June 13, 1931, 4♂, 4♀. Rock Island: June 23, 1928, 3♀; July 7, 1929, 1♀; June 24, 1931, 2♀. Rockton: July 2, 1931, ♂♂, ♀♀. Savanna: June 22, 1892, 2♂, 4♀; July 19–26, 1892, 17♂, 15♀; July 20, 1927, ♂♂, ♀♀. S. Beloit: July 1, 1931, 1♀. Sheldon: June 4, 1932, 1♂. Springfield: June 2, 1885, 2♀; June 23–24, 1885, 1♀. St. Joseph: May 26, 1912, 1♂; June 25, 1927, 1♂. Thebes: June 29, 1909, 1♀. Urbana: June 25, 1889, 2♂; June 24, 1891, 1♂; June 27, 1892, 2♂; July 3, 9, 18, 1892, 2♂, 2♀; Aug. 3, 1892, 1♀; May 24, 1899, 1♀; July 5, 1907, 1♂, 1♀; June 17, 1929, 1♂, 1♀; June 9, 1933, ♂♂, ♀♀. Warsaw: June 10, 1932, 1♂. White Heath: June 18, 1906, 2♀; June 24, 1916, 1♂. Wilmington: June 12, 1931, ♂♂, ♀♀. Zeigler: June 15, 1929, 1♂, 1♀.

Nymphs.—Allerton (trib. of Salt Fork r.): June 17, 1929. Altamont (Second cr.): Apr. 11, 1932. Brockton (Catfish cr.): Mar. 28, 1932. Byron (Rock r.): May 23, July 8, 12, 1927. Castle Rock (Rock r.): May 26, 1929. Dixon (Rock r.): May 2, 12, 22, 1925; June 17, 21–23, 1927. Elgin (Fox r.): June 18, 1931, exuviae. Golconda (Ohio r.): May 13, 1932. Goodfield (Mackinaw r.): June 16, 1931. Grafton (Mississippi r.): May 20, 1932. Grand Detour (Rock r.): July 27, 1927. Hill (trib. of Bishop cr.): Apr. 4, 1932. Homer (Salt Fork r.): May 12, 1928; June 17, 1930. Kankakee (Kankakee r.): June 12, 1931. Keithsburg (Mississippi r.): June 15, 1931, exuviae; 1932. Loch Haven (Piaso cr.): Apr. 10, 1932. Muncie (Stony cr.): June 8, 1927. Oakwood (Middle Fork of Vermillion r., Salt Fork r.): June 6, 1925; June 2, 1927; May 21, 1928; June 29, 1929; May 1, 1932; Apr. 12, 1933. Oliver (trib. of Big cr.): May 11, 1933. Oregon (Rock r.): June 29, July 3–6, 1927; July 11, 1929; May 15, 1930; June 18, 1931. Ottawa (Illinois r.): June 21, 1901, exuviae. Rockford (Rock r.): July 15, 1927. Rock Island (Rock r.): July 7, 1929; June 3, 1930; June 8, 13, 24, 1931. Shelbyville (Kaskaskia r.): Apr. 9, 1932. Starved Rock (Illinois r.): June 13, 1901, exuviae. Sterling (Rock r.): May 4, 15, June 15, 1925; June 13, 1927. Sterling—Dixon (Rock r.): May 21, 1925. St. Elmo (S. Fork cr.): Apr. 11, 1932. Vandalia (Kaskaskia r.): Apr. 10, 1932. Vienna (Rocky Branch): Mar. 27, 1932. Watson (trib. of Little Salt cr.): Apr. 7, 23, 1932. White Heath (Sangamon r.): May 13, 1928. Wilmington (Kankakee r.): June 12, 1931. Yorkville (Fox r.): June 18, 1931.

Reared from nymphs.—Oakwood: June 29, 1929.

Mating pairs.—Homer (park): June 30, July 11, 1927. Momence: June 4, 1932. Rockford: July 18, 1927.

Acroneuria Pictet

Pictet (1841) p. 144. Genotype *Perla arenosa* Pictet = *Acroneuria arenosa* (Pictet), original designation.

The genus *Acroneuria* was originally proposed by Pictet as a subgenus of *Perla*, and *arenosa* from North America cited as its type. *Abnormis* (Newman) was included in the subgenus *Acroneuria* at the time of its erection but it is evident from the statements of Pictet that he knew *abnormis* only from Newman's description and not from actual specimens.

Although the adults of *Acroneuria* are very large for stoneflies and

a few specimens are found in most general collections, the various species have been badly confused due to lack of proper association of males and females, and actual scarcity of good series of specimens. Klapalek's (1909a) revision of *Acroneuria* is helpful but quite inadequate due to these limitations. Needham and Claassen (1925) have contributed the best analysis of our *Acroneuria* fauna and I am following their nomenclature, synonymy and specific concepts except as noted under the various species discussed.

Since *A. arenosa* (Pictet) in the sense of Needham and Claassen has not been found in Illinois it may be well to say a word here concerning this species. Needham and Claassen (1922, 1925) have associated the name of *arenosa* with an eastern species which is peculiar in having the "second anal vein of the hind wing many (about 12) branched." The original description of *arenosa* mentions no such peculiarity and Pictet's fig. 2 on plate 10 of his justly celebrated work does not show such venation—at least I cannot interpret these drawings as showing a many branched second anal vein comparable to that found in the species we are now calling *arenosa*. A future study of the types, if they are in existence, may show that the North American species going by the name of *arenosa* does so improperly, and that *arenosa* should replace the name now in use for some other eastern species of *Acroneuria*.

Needham and Claassen recognize 17 species of *Acroneuria* from North America, five of which are known only from the western parts of the United States or provinces of Canada. Our studies of the Illinois fauna indicate that one of these, *evoluta* Klapalek, is a synonym of *arida* (Hagen), leaving a total of 16 species. Of these we have reared and definitely associated the sexes of four species, *arida*, *internata*, *abnormis* and *ruralis*, and located the cast skins of possibly two others. The questionable species (*sp. a* and *sp. b* in key to nymphs, p. 391) are represented by cast skins only, one form (*sp. b*) by one cast skin and the other form (*sp. a*) by four cast skins. Lack of material of the forms just mentioned is a good indication of their extreme rarity in Illinois, in view of our very thorough collecting, both in season and area.

The adults of all the Illinois species are nocturnal and are attracted to lights near the rivers where the nymphs develop. During the day the adults rest in any place where they can find shelter, particularly from direct sunlight. They have not been observed to feed and their mouthparts indicate they are incapable of utilizing solid food. All of the species are true members of the early summer fauna.

The nymphs as a result of their large size, often conspicuous markings and long developmental period are collected more frequently by the general student of aquatic life than most other genera of stonefly nymphs.

Unlike *Allocapnia* the nymphs are readily separated to species and even the cast skins are usually sufficient for specific identification. Examination of the alimentary tracts of nymphs of all the reared Illinois species reveals that they are carnivorous. Like many other species the nymphs are not so partial to the association or a cover of stones as the literature or their name might indicate and at times certain species can be obtained most easily in accumulations of leafy debris lodged in or near the edges of the streams they inhabit. The long life cycle of the nymphs, two or perhaps in some cases three years, necessitates the restriction of the nymphs to medium or large rivers which are not likely to go dry in the summer months. An abundant and more or less constant invertebrate animal food supply is undoubtedly another factor eliminating large *Acroneuria* nymphs from the very small streams which are suitable for development of *Allocapnia*, *Leuctra*, *Nemoura*, *Capnia*, certain species of *Isoperla* and others.

KEY TO SPECIES

Adults

1. Ninth ventral abdominal segment greatly produced posteriorly and recurved upward so that tenth segment is mostly or entirely concealed; with a raised disk in middle of posterior portion, fig. 302. Eighth ventral segment about similar to preceding segments and never produced over ninth. Subanal lobes well developed and recurved over dorsal surface of tenth dorsal segment, fig. 211, (males).....2
 Ninth ventral abdominal segment not greatly enlarged and not covering tenth segment; without a raised disk, fig. 247. Eighth ventral segment often with posterior margin produced over ninth segment, fig. 250, or with a hump anterior to posterior margin, fig. 244. Subanal lobes not well developed and not recurved over dorsal surface of tenth dorsal segment (females).....5
2. Subanal lobes finger-like, fig. 208.....3
 Subanal lobes broad and somewhat triangular, fig. 211.....4
3. Disk on ninth ventral abdominal segment small, much smaller than diameter of compound eye.....*arida*, p. 397
 Disk on ninth ventral abdominal segment larger, but slightly smaller than diameter of compound eye.....*internata*, p. 401
4. Numerous short spinelike setae on ninth and tenth dorsal abdominal segments, fig. 210.....*abnormis*, p. 391
 No short spinelike setae on ninth or tenth dorsal abdominal segments, fig. 211.
 A declivitous basin-like area on middle posterior part of tenth segment, fig. 211.....*ruralis*, p. 403
5. Eighth ventral abdominal segment (subgenital plate) but little produced over ninth segment, fig. 248.....*abnormis*, p. 391
 Eighth ventral abdominal segment (subgenital plate) considerably produced over ninth segment, fig. 244.....6
6. With a raised disk or hump on posterior portion of eighth ventral abdominal segment, fig. 244.....*ruralis*, p. 403

ACRONEURIA—KEY TO SPECIES—CONT'D

- Without a raised disk or hump on eighth ventral abdominal segment, figs. 246, 247.....7
7. Eighth ventral abdominal segment much produced over ninth segment, figs. 243, 246.....*arida*, p. 397
- Eighth ventral abdominal segment less produced over ninth segment and with a flaplike process at each lateral posterior corner, fig. 247....*internata*, p. 401

Nymphs

1. Abdomen with anal gills.....2
- Abdomen without anal gills.....3
2. Dorsal segments of abdomen with alternating light and dark transverse bands. Head with a continuous light, often W shaped, transverse band anterior to median ocellus, fig. 313.....*arida*, p. 397
- Dorsal segments of abdomen entirely dark. Head with five light spots on a dark background anterior to epicranial arms, fig. 316.....*sp. a*, p. 405
3. Head unicolorous, brown. An occipital ridge present on posterior margin of head, fig. 315.....*ruralis*, p. 403
- Head with light spots or an irregular, sometimes W shaped, band contrasting with dark background. No occipital ridge present.....4
4. Dorsal segments of abdomen entirely dark, fig. 309.....*abnormis*, p. 391
- Dorsal segments of abdomen with transverse light bands or areas alternating with dark bands or areas.....5
5. Head anterior to epicranial arms with five light spots contrasting with dark background. Light areas on dorsum of abdominal segments transverse, bandlike and parallel with dark bands, fig. 314.....*internata*, p. 401
- Head anterior to anterior ocellus with a light transverse, more or less W shaped, band. Light area on dorsum of abdominal segments tending to divide dark bands along meson into right and left detached dark areas, fig. 317.....*sp. b*, p. 407

Acroneuria abnormis (Newman)

Figs. 3, 23, 34, 64, 94, 124, 151, 182, 210, 248, 301, 309, 310, 311, 312.

Perla abnormis Newman (1838) p. 177. Original description.

Acroneuria abnormis Claassen (1931) p. 82. Nymphal description.

I am convinced from a study of an extensive series of adults and nymphs of *Acroneuria* from various localities in Illinois that if *pennsylvanica* (Rambur) is a valid species it does not occur in Illinois, and that our commonest species should be associated with the name *abnormis* (Newman). Our state material has also led me to believe that *abnormis* and *pennsylvanica* are synonymous, the former name having priority.⁸

⁸ Examination of eastern stoneflies in the collections of the United States National Museum, the Museum of Comparative Zoology and the Carnegie Museum, made at the time this paper was in final proof, demonstrated the existence of an eastern species of *Acroneuria*, which in part, correctly or incorrectly from the nomenclatorial standpoint, is going by the name of *pennsylvanica*. I am accepting the use of this name for such eastern material as was examined, while awaiting further studies of types and the development of evidence on the number of species in the genus. For the latter, a decision as to the number of distinctive nymphs is essential.

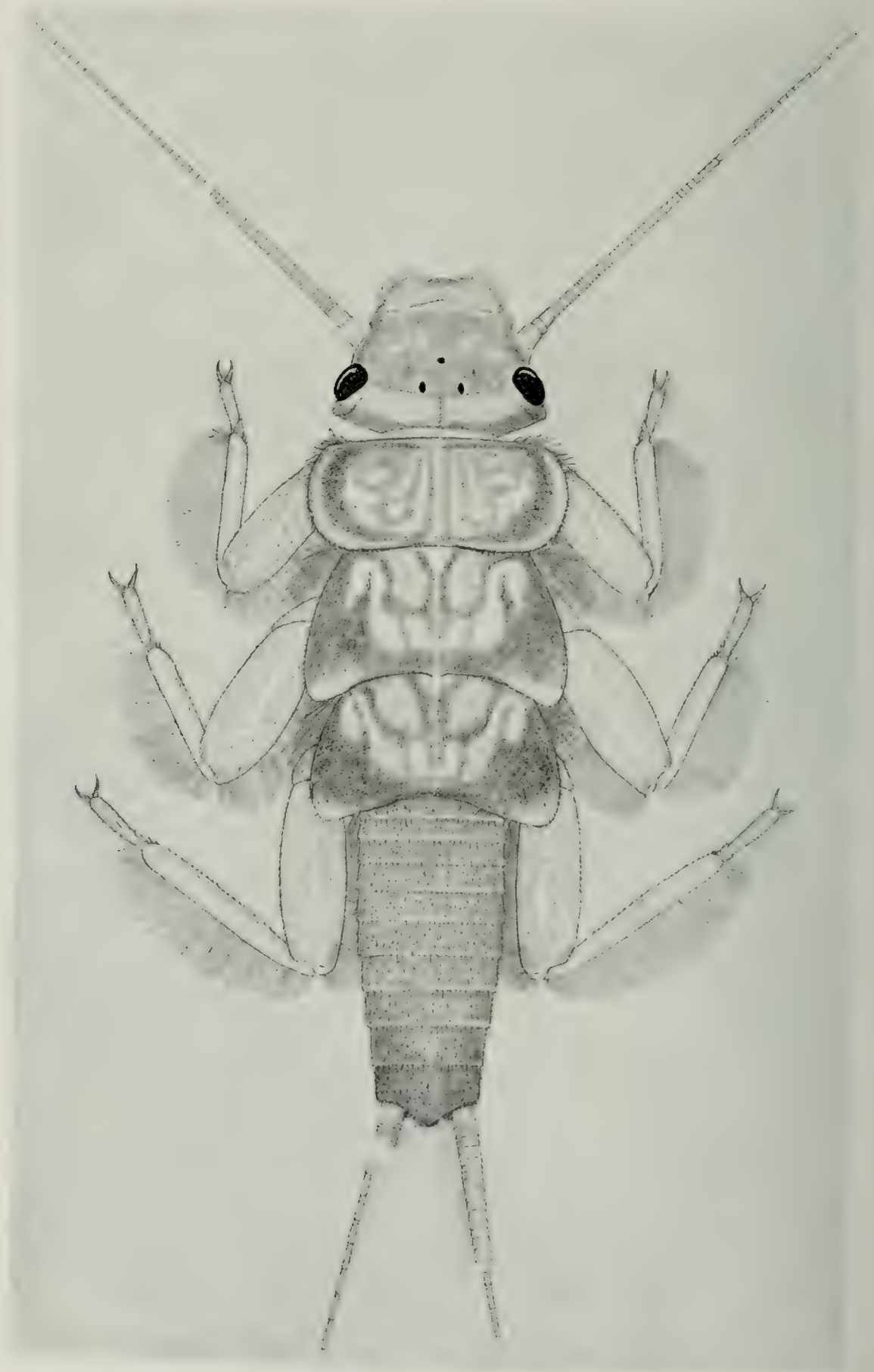
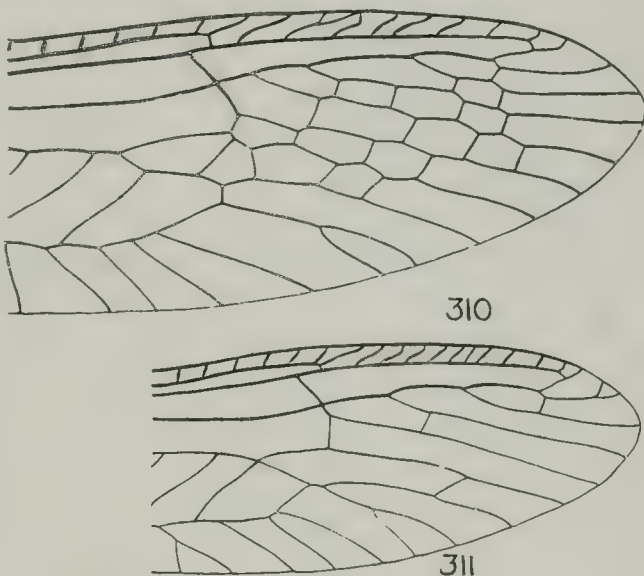


Fig. 309.—*Acroneuria abnormis*, NYMPHAL FEMALE. -

My reasons for this belief are as follows: 1.—Existing distributional records assigned to these two names indicate they have the same general range. This parallelism in range is not in itself proof of likeness, but coupled with other facts it tends to show the existence of only a single species. 2.—The number of crossveins in the area beyond the cord in the forewing is subject to great variation. At present this character is practically the basis on which *abnormis* and *pennsylvanica* are separated in the keys in literature. Reared adults, mating pairs and other material, which I am certain represent but one species, can be keyed to both of these names in the keys of Needham and Claassen (1922, 1925). In figs. 310,

311 are shown the forewings of a male and female collected while *in coitu*; this female will key to *abnormis* and the male to *pennsylvanica*. A tabulation made of the crossveins beyond the cord in the forewings of numerous males and females from Illinois shows that the crossveins are rarely the same number in the right or left wings of the same individual, the range in variation runs from two to 14, and the males and females are equally variable. 3.—The nymphs in Illinois producing adults of the *abnormis* or the *pennsylvanica* type are similar, agree



Figs. 310-311.—TIPS OF RIGHT FOREWINGS OF *Acroneuria abnormis*. Note variation in number of crossveins in wings of same species. **310.**—Female. **311.**—Male. Drawn from the wings of a mating pair.

with nymphs determined by Claassen as *abnormis*, fit very well the essential characters of his excellent description of it and run in his key of nymphs to this species. Studies of nymphs to date have failed to reveal a distinctive nymph which can be definitely assigned to *pennsylvanica*. 4.—I believe that too much emphasis or the wrong inference has been placed upon Klapalek's (1909a) recognition of *abnormis* and *pennsylvanica* as separate species. Although Klapalek calls his 1909a paper a revisional study it is based upon a serious paucity of material and it has many limitations. According to Klapalek the *pennsylvanica* Rambur is a different species and his poor illustration of the type female attempts to portray in part this difference. Hagen (1861) placed *pennsylvanica* in the synonymy of *abnormis* and his use of an exclamation point behind the author's name

of each species indicates, as stated in his introductory remarks, that he studied the types of both. In addition Hagen described a new species *ruralis* and pointed out the most essential recognition characters for the female of this species—the produced subgenital plate and a hump or raised callosity (transverse tubercle) on this plate before its apex. If the type of *pennsylvanica* Rambur had such a structure it seems queer that it would be overlooked by Hagen. Klapalek did not redescribe or place in synonymy *ruralis* (Hagen) or its synonym *rupinsulensis*, states that he did not know these species, and therefore might have found the type of *pennsylvanica* to have a produced subgenital plate, and recognized it as a valid species equivalent to what we are calling *ruralis*. Failure to mention the peculiar hump on the subgenital plate however tends to indicate *pennsylvanica* Rambur is not the same as *ruralis*, in keeping with Hagen's view.

What, then, is *pennsylvanica* Rambur? It is my belief that it is a female of *abnormis* which has so dried that the prolongation and shape of the subgenital plate is not normal. It should be stated too that there is some variation in the degree of prolongation of the subgenital plate of the females of what I am calling *abnormis* and which I am sure are one species. Klapalek even states that the subgenital plate of the type is damaged, which might not have been the case when Hagen examined it. If the type is ever found to show a transverse callosity or tubercle before the apex of the subgenital plate, the name *pennsylvanica* would have priority over *ruralis*. Regardless of the status of *pennsylvanica*, all our Illinois material of the species under discussion must be associated with the oldest name—*abnormis*.

Hagen (1861) first recorded *abnormis* from "South Illinois (Robt. Kennicott)," followed by Walsh (1862, 1863) from near Rock Island, Ill. Garman (1888) mentions the nymph as "Plecoptera, nymph" from Willow slough near Quincy, Ill. The existence of Garman's nymphal specimens in our collection makes possible this placement of his reference. In spite of its abundance I know of no other records for its occurrence in this state. Our collecting of the past few years shows *abnormis* to be the most common of our *Acroneuria* fauna and present in all parts of the state. According to the literature it also occurs in Canada, the District of Columbia, Maryland, New York, North Carolina, Pennsylvania, Tennessee and West Virginia. Future collecting will undoubtedly reveal its presence in most states east of the Rocky mountains.

All of our adults have been collected or reared during May and June and the maximum abundance of the adults is about the middle of the latter month. They are therefore members of the late spring and early summer fauna. Like the other Illinois *Acroneuria*, the adults are nocturnal and are attracted to lights near large rivers.

The nymphs are restricted to the medium or large rivers. They are carnivorous, as evidenced by insect remains in the alimentary tract of a nymph collected in the Rock river at Rock Island, Ill., April 2, 1928. Our association of nymphs with adults is based upon many rearings of both sexes.

Distinctive features of the adults are shown in figs. 210, 248, 310, 311. The nymph has been well characterized by Claassen (1931). Its important morphological features are given in figs. 3+, 6+, 9+, 12+, 151; the color pattern as shown in fig. 309 is subject to variation in the relative amounts of light or dark areas, fig. 312.

Adults.—Dixon: May 31, 1914, 1♀. Elizabethtown: May 28–30, 1928, 3♂. Grand Tower: June 2, 1913, 1♂. Homer (park): June 30, 1927, 1♀. Kankakee: June 12, 1931, 3♂, 2♀. Metropolis: June 1, 4, 1928, 3♂, 1♀. Oregon: June 20, 1917, 1♂; May 21–June 15, 1928, 1♂, 2♀; May 1929, 1♀; June 1930, 3♀. Pike: May 26, 1906, 9♂, 11♀. Rockford: June 13, 1931, 1♀. Rock Island: May 21, 1928, 3♀; June 3, 1930, 2♂, 12♀; June 8, 13, 24, 1931, 1♂, 7♀. Savanna: June 11; 1917, 1♂. Shawneetown: June 21, 1927, 1♀. Sterling: May 21, 1925, 1♀. Urbana: June 8, 1905, 1♂.

Nymphs.—Byron (Rock r.): July 8, 11, 1927. Charleston (Embarrass r.): June 8, 1931, exuviae. Dixon (Rock r.): Apr. 3, 1928. Dixon—Oregon (Rock r.): July 27, 1927. Duncan Mills (Spoon r.): Sept. 2, 1910. Fulton (Mississippi r.): Sept. 11, 1932. Grafton (Illinois r.): Aug. 30, 1913; Sept. 8, 1932. Kampsville (Illinois r.): Aug. 22, 1913. Kankakee (Kankakee r.): June 12, 1931. Keithsburg (Mississippi r.): June 15, 1931; June 8, 1932, exuviae. Meredosia (Illinois r.): Sept. 5, 1913. Oregon (Rock r.): Apr. 3, 1928; July 11, 1929. Pike (Illinois r.): May 26, 1906, exuviae. Prophetstown (Rock r.): July 29, 1925. Quincy (Willow slough, Mississippi r.): Aug. 7, 1888. Rockford (Rock r.): May 4, 1926; June 13, 1931. Rock Island (Rock r.): Apr. 2, 1928; Apr. 10, 1931; Apr. 27, May 9, 1932; May 11, 1934. Savanna (Mississippi r.): Sept. 11, 1932. Wilmington (Kankakee r.): Apr. 28, 1931.

Reared from nymphs.—Rockford (Rock r.): June 12, 13, 1931. Rock Island (Rock r.): June 3, 1930; June 8, 13, 1931.

Mating pairs.—Rockford: June 13, 1931. Rock Island: June 3, 1930; June 13, 1931.

Acroneuria arida (Hagen)

Figs. 35, 65, 95, 125, 155, 208, 242, 243, 246, 250, 313.

Perla arida Hagen (1861) p. 18. Original description.

Acroneuria evoluta Klapalek (1909a) p. 245. New synonymy (♀).



Fig. 312.—DORSAL ABDOMINAL SEGMENTS OF *Acroneuria abnormis*, NYMPH, LIGHT FORM.



Fig. 313.—*Acroneuria arida*, NYMPHAL FEMALE.

This species has been previously recorded from Galena, Ill. by Needham and Claassen (1925). *Arida* is also listed as occurring in Arkansas, the District of Columbia, Indiana, Kansas, Missouri, New York, Ohio, Tennessee and Texas. This scattering indicates that it is likely to be found in most of the states east of the Rocky mountains.

Study of a large series of specimens from Illinois, specimens from other states which are unnamed or were previously named as *evoluta*, and the original descriptions have convinced me that *arida* (Hagen) and *evoluta* Klapalek are identical and not distinct species as considered by Needham and Claassen (1925). The shape of the eighth ventral abdominal segment is quite distinctive although subject to some variation, figs. 242, 243, 246, 250. I am certain that my extensive Illinois material named as *arida* and showing in some instances variations in the shape of the subgenital plate constitutes a single species because of reared material, mating pairs, similar nymphs and numerous bits of biological evidence. When Klapalek (1909a) described *evoluta* he was not aware of the essential characters of *arida* as is proved by his placing of *arida* as a synonym of *arenosa*, the subgenital plate of which according to his own illustration (fig. 7) is different from that he gives for *evoluta* (fig. 9—typical of what is here called *arida*).

Recently there has appeared an article by Clark (1934) which describes in considerable detail the adult of this species under the name of *evoluta*. I have studied a specimen from Put-in-Bay, Ohio, kindly sent to me by Professor C. H. Kennedy, which is similar to the adults studied by Clark. The study of this specimen confirms my previous belief based upon the article itself that Clark failed to record the presence of the remnant or vestigial thoracic gills in his description and omitted them in his drawings. Their omission would indicate that the specimens studied by Clark did not belong to the Perlidae as I now limit this family. This is not the case.

As suggested above with reference to the genus I doubt whether the name *arenosa* Pictet has been correctly associated with the proper species. *Arenosa* might have been the species here called *arida* (*evoluta*) or one or two other species from eastern North America. The nomenclature of Needham and Claassen however will be followed except for the synonymy indicated, until there is evidence to the contrary based upon typic material.

Specimens of *arida* have been collected in most sections of Illinois except from the northwestern counties. It also happens that most of our material comes from the eastern side of the state. I am inclined to believe that the difference in number of records from the eastern and western sides of the state is mostly the result of unbalanced collecting, but the com-

plete absence to date of specimens from northwestern Illinois cannot be thus dismissed. The Rock river is located in northwestern Illinois and our collecting in this stream has over a period of years been qualitatively and quantitatively as thorough as in most other parts of the state.

The adults begin to emerge around the first of June and in central Illinois reach their maximum abundance about the last of this month. They must therefore be considered a member of the early summer fauna. Although the nocturnal adults are usually not abundant, I have collected more than 100 in one evening at lights near a dam on the Salt Fork river near Homer. Mating takes place at night and often while the adults are concentrated near lights.

Heretofore the nymph of *arida* has not been definitely associated with its adult. Claassen (1931) mentions in the introduction of his book that Garman's (1912) fig. 47 "represents *Acroneuria*, probably *arida* Hag." In his key to nymphs of *Acroneuria* Claassen includes *arida* and also presents one drawing and one photograph which he labels as *arida*. A description such as is given for other species of *Acroneuria* is not given and localities are not associated with his figures. A comparison of his two illustrations reveals a possibility of their representing one, possibly two, species neither of which corresponds to the nymphs which I have reared and hence definitely associated with *arida* (*evoluta*). I believe however that the figure given by Garman based upon material from Kentucky is identical with *arida*. Garman's figure indicates transverse strips on the abdominal tergites whereas Claassen's figures and statements show he was dealing with a species with uniformly dark abdominal tergites.

That the nymphs are carnivorous is proved by the dissection of a specimen collected in the Kankakee river, Kankakee county, Ill., June 1, 1901, which contained numerous insect remains in the alimentary tract.

The most distinctive features of the adults, which have been described by others as noted above, have been given here in the key to species, p. 390, and are shown in figs. 208, 242, 243, 246, 250.

Most important characters of the previously undescribed nymph are as follows.

Nymphal female, fig. 313.—General ground color yellowish with brownish markings on dorsum as follows: labrum except for extreme anterior tip; two transverse sinuate bands on head connected by narrow line on side of head adjacent to antennae—one of these bands crosses the head just anterior to articulation of antennae and the second is located on a line with anterior portion of compound eyes with its greatest width in middle of head where it fills the ocellar space; extreme posterior edge of head; a series of

dark markings on pro-, meso- and metanotum as shown in fig. 313; transverse bands on anterior margins of abdominal tergites, these bands being widest on middle tergites; bands at base and apex of femur.

Head with three ocelli forming an equilateral triangle; lateral ocelli larger than anterior ocellus and situated about on a line with the middle of compound eyes; anterior ocellus placed anterior to a line connecting anterior points of compound eyes. No occipital ridge. Posterior margin of compound eye with a row of short stout prominent setae. Labrum, fig. 35, labium, fig. 125, maxilla, fig. 95, mandibles, fig. 65, and submentum, fig. 155, as illustrated.

Pronotum much broader than long; angles or corners well rounded, especially hind angles; anterior margin slightly bulging forward and hind margin slightly indented in middle; marginal groove well defined and completely extending around pronotum; flange widest on sides. Meso- and metanotum with wing pads well developed; lateral margins broadly rounded, particularly mesonotal wing pads.

Legs flattened; femora much broader than tibiae and well covered with short stout setae; hind margin of femora and tibiae with a fringe of long dense setae.

Abdomen shaped and marked as in fig. 313. Cerci much shorter than body, with 40 or more segments; basal segments much broader than long, middle and apical segments much longer than broad. Tenth abdominal sternite but slightly produced backwards on posterior margin. Eighth abdominal sternite with posterior margin straight; posterior setal fringe interrupted in middle.

Gills present; two pairs of large, many branched clumps on the side of each thoracic segment near articulation of legs; one pair at apex of abdomen.

Mature specimens with a body length, exclusive of appendages, sometimes as much as 23 mm.

Nymphal male.—Similar to female in general color and most morphological details. Eighth abdominal sternite with row of setae on posterior margin not interrupted in middle. Mature specimens smaller than females with a body length up to 17 mm.

Adults.—Anna: June 8, 1907, 1 ♂. Aurora: July 17, 1927, 1 ♀. Cairo: June 27, 1905, 1 ♀. Champaign: June 17, 1886, 1 ♀.; June 12, 15, 1888, 2 ♂. Charleston: June 8, 11, 1931, 3 ♂, 1 ♀. Effingham: June 20, 1927, 1 ♂. Elizabethtown: June 22, 1927, 1 ♂; June 24, 1932, 1 ♂. Homer: July 19, 1924, 1 ♀; June 30, 1927, 42 ♂, 73 ♀; July 6–11, 1927, 1 ♂, 8 ♀; June 14–17, 1930, 4 ♂, 1 ♀; June 11, 1931, 8 ♂, 2 ♀. Kankakee: June 13, 1931, 1 ♂. Metropolis: June 4–6, 1928, 4 ♂. Momence: June 4, 1932, ♂♂, 1 ♀. Muncie: July 27, 1927, 1 ♀; July 3, 1929, 1 ♂. Oakwood: June 9, 1926, 1 ♀; July 6, 1927, 1 ♂, 4 ♀. Ogden: June 14, 1930, 1 ♂; June 17, 1933, 1 ♀. Petersburg: June 9, 1914, 1 ♂. Shawneetown: June 21, 1927, 3 ♂. Urbana: June 24–25, 1889, 1 ♂, 1 ♀; July 5, 1907, 2 ♀; June 17, 1929, 1 ♂. Wilmington: June 12, 1931, 1 ♂.

Nymphs.—Charleston (Embarrass r.): Dec. 6, 1930; Mar. 22, Apr.

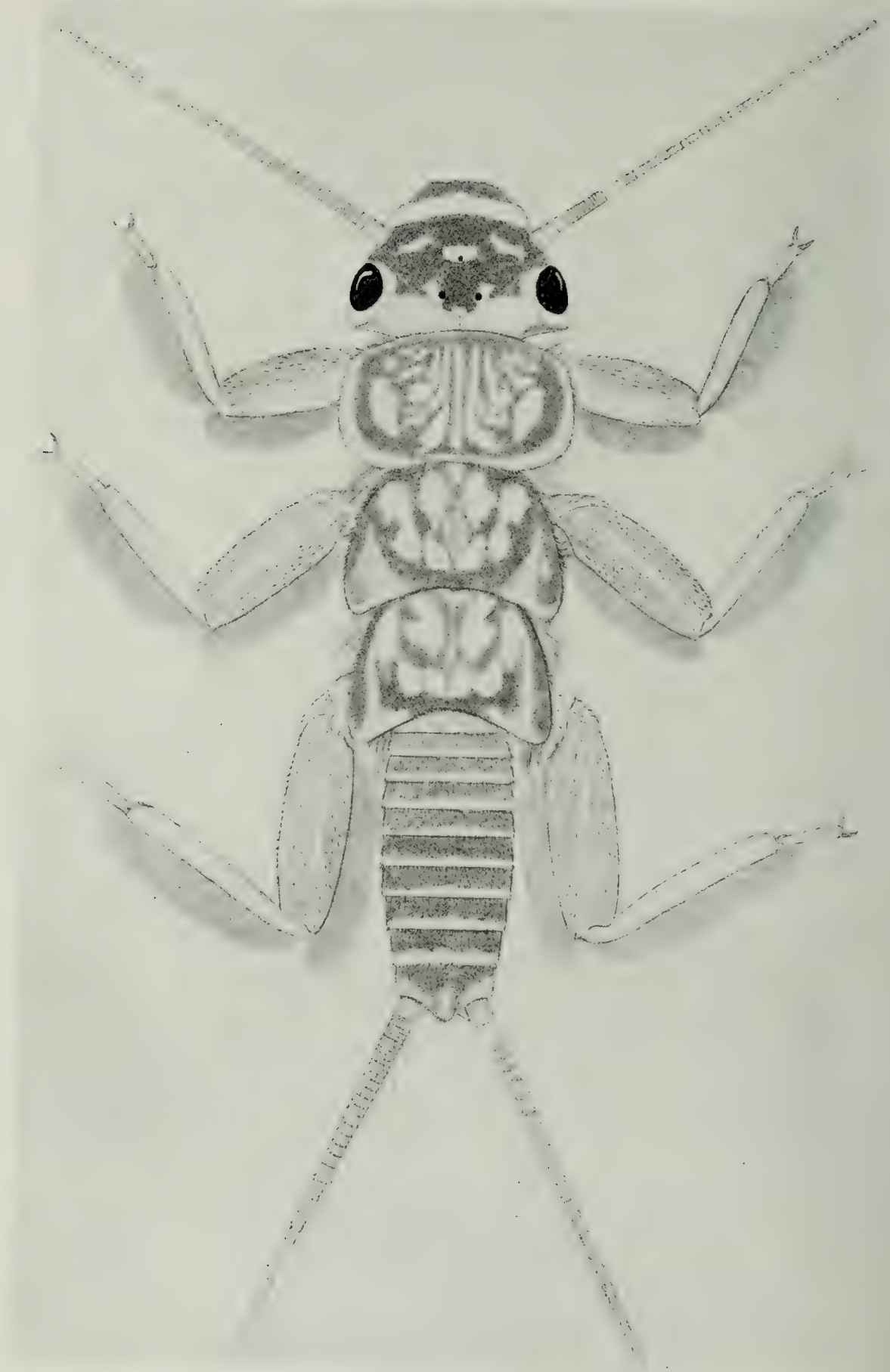


Fig. 314.—*Acroneuria internata*, NYMPHAL FEMALE.

2, 17, June 7, 1931; Mar. 28, 1932. Golconda (Ohio r.): May 13, 1932. Homer (Salt Fork r.): Apr. 20, 1921; June 3, 1925; June 14, 1930; Apr. 18, 1931. Kankakee (Kankakee r.): June 1, 1901, Apr. 28, 1931. Mahomet (Sangamon r.): Sept. 1, 1928. Muncie (Stony cr.): May 27, 1905; June 8, 1927. Oakwood (Salt Fork r.): June 6, 1925; Sept. 1, 1927; Nov. 2, 1929; Sept. 8, 1932; Apr. 12, 1933. Ottawa (Illinois r.): June 12, 1901, exuviae.

Reared from nymphs.—Charleston (Embarrass r.): June 8, 11, 19, 1931. Homer (Salt Fork r.): June 14, 1930.

Mating pairs.—Homer (park): June 30, 1927.

Acroneuria internata (Walker)

Figs. 36, 66, 96, 126, 159, 209, 247, 266, 314.

Perla internata Walker (1852) p. 152. Original description.

Acroneuria internata (Walker), or the species now going under this name in North America, has remained almost unknown to workers on Plecoptera. Practically all authors until Needham and Claassen (1922) have placed *internata* in the synonymy of one or more species or dismissed it as unrecognizable. Needham and Claassen (1925) first recorded it from Illinois (Bloomington, June 21, 1894, C. C. Adams) and also list it from Colorado, Indiana, Michigan, Missouri and West Virginia. These records indicate it is to be expected in most of the states in the Mississippi watershed.

Our picture of its distribution in Illinois parallels that of *A. arida* (Hagen), which see.

Field studies indicate that this stonefly is the least abundant of the Illinois species of *Acroneuria* that are known in the adult stage. Most of our adults have been collected at night at lights and not before the first week in June. Our latest date for the collection of an adult is July 28. Rearings of adults from nymphs indicate their maximum abundance to occur about the end of June. The adult is to be considered therefore as a member of the late spring and early summer fauna.

The adults have been well described by Needham and Claassen (1925). Their distinctive features for identification purposes are given in the key to species and in figs. 209, 247.

The nymph of *internata* has not been previously described or recorded. Our association of nymph with adult is based upon rearings of both sexes and our association of sexes upon emergence of opposite sexes from similar nymphs. That the nymphs are carnivorous and afford no exception to the rule among *Acroneuria* is evident by the finding of numerous insect remains in the alimentary tract of a nymph collected in the Embarrass river, Charleston, Ill., March 22, 1931.

Description of the previously unrecognized nymph follows:

Nymphal female, fig. 314.—General ground color yellowish with brownish markings on dorsum as follows: labrum; most of central area of head except for five more or less definite light spots, three of which are adjacent to ocelli and one on each side of head between anterior ocellus and base of antenna; small area on posterior margin of head feebly connected at sides with posterior margin of compound eye; a series of markings on pro-, meso- and metanotum as shown in the figure; abdominal tergites except for narrow yellow posterior margins; and large portion of femur.

Head with three ocelli forming a triangle, lateral ocelli slightly closer to one another than to anterior ocellus; lateral ocelli much larger than anterior ocellus and placed about on a line with middle point of compound eyes; anterior ocellus placed anterior to a line connecting anterior points of compound eyes. No occipital ridge. Posterior margin of compound eyes with a row of short stout prominent setae. Labrum, fig. 36, labium, fig. 126, maxilla, fig. 96, mandibles, fig. 66, and submentum, fig. 159, as illustrated.

Pronotum much broader than long; hind angles much rounded, front angles sharper; anterior margin slightly bulging forward and hind margin slightly indented towards middle; marginal groove well defined and extending completely around pronotum; flange widest on sides. Meso- and metanotum with wing pads indicated; lateral margins rounded.

Legs flattened; femora much broader than tibiae and well covered with short stout setae except for a bare median longitudinal stripe; hind margins of femora and tibiae with a fringe of long dense setae.

Abdomen shaped and marked as in fig. 314. Cerci much shorter than body, with 50 or more segments; basal segments much broader than long, middle segments slightly longer than broad, apical segments much longer than broad. Tenth sternite but slightly produced backwards on posterior margin. Eighth sternite with posterior margin straight; posterior setal fringe interrupted in middle.

Gills present, fig. 266; two pairs of large, many branched clumps on the sides of each thoracic segment near articulation of legs; anal gills absent.

Mature specimens with a body length, exclusive of appendages, sometimes as much as 27 mm.

Nymphal male.—Similar to female in general color and most morphological details. Eighth abdominal sternite with row of setae on posterior margin not interrupted in middle. Mature specimens smaller than females, with a body length up to 15 mm.

Adults.—Charleston: June 8, 1931, 1♀. Kankakee: July 10, 1925, 2♂, 2♀. Metropolis: June 6, 1928, 1♂. Muncie: July 6, 1907, 1♂. Oakwood: June 6, 1925, 1♂; July 6, 1927, 1♀; July 28, 1929, 1♀; June 14, 22, 1930, 5♂. Shawneetown: June 21, 1927, 1♂.

Nymphs.—Charleston (Embarrass r.): Nov. 14, Dec. 14, 1930; Mar. 22, Apr. 2, 17, 1931. Kankakee (Kankakee r.): June 1, 1901. Oakwood (Salt Fork r., Middle Fork of Vermilion r.): June 16, 1925; Sept. 1, 1927; Nov. 18, 1928; May 3, 1931; May 1, 1932; Apr. 12, 1933. Ottawa: June 12, 1901, exuviae.

Reared from nymphs.—Charleston: May 31, June 7, 8, 11, 14, 19, 1931.

Acroneuria ruralis (Hagen)

Figs. 37, 67, 97, 127, 147, 211, 244, 302, 315.

Perla (*Acroneuria*) *ruralis* Hagen (1861) p. 18. Original description (♀).

Acroneuria ruralis Claassen (1931) p. 89. Nymphal description.

Acroneuria ruralis, the largest of the Illinois species of this genus, was first recorded from near Rock Island, Ill. by Walsh (1862) and again in 1863, both times under the name of *rupinsulensis* Walsh. The description of the produced subgenital plate of the female and "a distinct transverse linear tubercle upon it" leaves no doubt that *rupinsulensis* is a synonym of *ruralis*. This synonymy was first indicated by Needham (1920). Types of *rupinsulensis* Walsh are now in the collection of the Museum of Comparative Zoology, Cambridge, Mass. The next records from Illinois (Bloomington, Moline and Savanna) are those by Needham and Claassen (1925). To date this species has been recorded east of the Rocky mountains from Canada and 11 states and is to be expected in most of the remainder, particularly those in the Mississippi watershed. The adults in our collection come from all sections of Illinois traversed by large or medium sized rivers.

Our records show that the adults begin emerging during the last of May, reach their maximum abundance about the middle of June, and a few are still about during the first of July; therefore the species is a member of the late spring and early summer fauna. The adults are nocturnal, attracted to lights and though not rare are seldom found in numbers.

The nymphs are restricted to medium or large rivers like other members of this genus. Our association of nymph with adult and males with females is based upon rearings. Like the other *Acroneuria* this species is carnivorous. The alimentary tract of a nymph collected in the Rock river, Rock Island, Ill., April 2, 1928, was found to be full of the remains of larvae of chironomids, caddice flies and other aquatic insects. The nymph has a developmental period certainly of two years and possibly three.

Distinctive features of the adults are given in figs. 211, 244, 302. The nymph has been adequately characterized by Claassen (1931) and

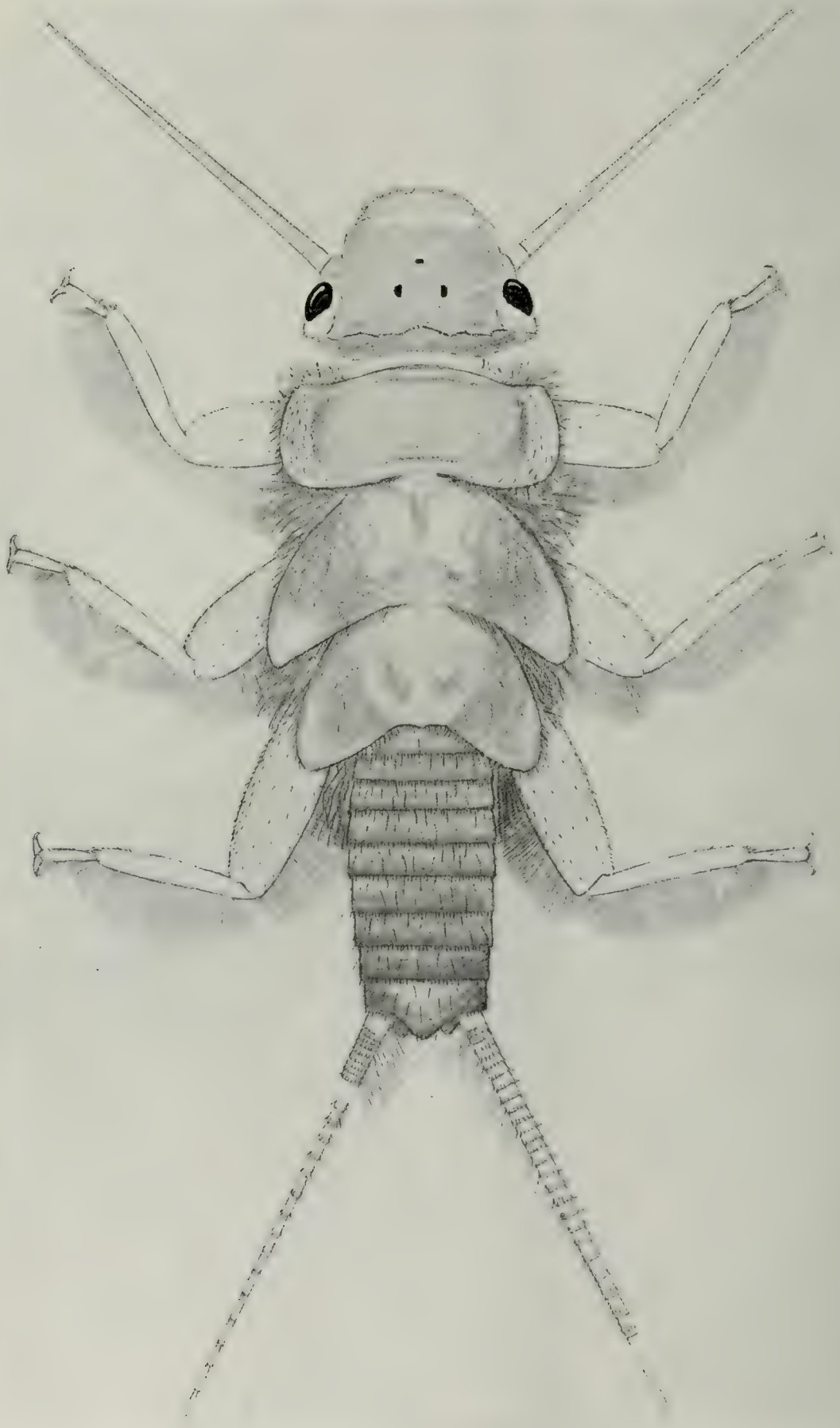


Fig. 315.—*Acroneuria ruralis*, NYMPHAL FEMALE.

its most important morphological characters are shown in figs. 37, 67, 97, 127, 147.

Adults.—Algonquin: June 29, 1906, 1♂. Bloomington: 1♀. Cairo: May 23, 1907, 1♂. Elizabethtown: June 22, 1927, 1♀. Galesburg: June 24, 1907, 2♀. Grand Tower: June 1, 1913, 1♀. Havana: June 28, 1907, 1♂; June 29, 1913, 1♂. Keithsburg: June 9, 14, 1932, 1♂, 3♀. Leroy: July 1, 1928, 1♂. Metropolis: June 4, 5, 9, 1928, 5♂, 2♀. Oregon: May 1929, 1♂, 2♀; June 1930, 1♂. Rock Island: June 3, 1930, 2♂, 1♀; June 13, 24, 1931, 3♂, 8♀. Shawneetown: June 21, 1927, 1♂. Urbana: June 5, 1907, 1♀; July 5, 1907, 1♀.

Nymphs.—Alton (Mississippi r.): Aug. 29, 1913. Geneseo (Green r.): Aug. 4, 1925. Grafton (Mississippi r.): Aug. 30, 1913; Sept. 8, 1932. Hillsdale (Canoe cr.): July 30, 1925. Keithsburg (Mississippi r.): June 9, 1932. Lyndon (Rock r.): July 8, 1925. Milan (Rock r.): Sept. 29, 1927. Oregon (Rock r.): Apr. 3, 1928. Prophetstown (Rock r.): July 20, 29, 1925. Rock Island (Rock r.): Apr. 2, 1928; June 3, 1930; May 16, 1931; Apr. 27, 1932; May 11, 1934. Savanna (Mississippi r.): Sept. 11, 1932. Sterling (Rock r.): Aug. 5, 12, 1924.

Reared from nymphs.—Rock Island (Rock r.): June 8, 13, 24, 1931.

Acroneuria sp. a

Figs. 38, 68, 98, 128, 166, 316.

Near Keithsburg, Ill. on the Mississippi river we have found clinging to the piling of a railroad bridge four cast skins of a species of *Acroneuria* which we cannot place to species. We are tentatively calling this *Acroneuria* "sp. a" until the adult is known. Considerable effort has been made to capture the live nymph or adult but so far to no avail. This species is certainly a rarity in Illinois. Judging by the location of Keithsburg (southwest of Rock Island) this is a northern species which has penetrated down the Mississippi river or its tributaries and in Illinois is at the southern edge of its distribution.

In general the nymph is suggestive of the nymph figured by Claassen (1931, Pl. 33, fig. 227) under the name of *arida*. The true *arida*, however, has a quite different nymph as described and illustrated in the present paper. In fig. 316 is shown our idea of the appearance of the nymph based upon cast skins. Although a detailed description of the nymph might be presented based upon the cast skin, such a description is left until the actual nymph and adults are known. The most important characters in addition to the color pattern are the presence of small anal gills in addition to thoracic gills and the absence of a prominent occipital ridge. The mouthparts are as follows: labrum, fig. 38, mandibles, fig. 68, maxilla, fig. 98, labium, fig. 128, and submentum, fig. 166.

Exuviae.—Keithsburg (Mississippi r.): June 14, 1931, 2♀; June 9, 1932, 1♂, 1♀.



Fig. 316.—*Acroneuria* sp. a, NYMPHAL FEMALE AS INDICATED BY EXUVIA.

Acroneuria sp. b

Figs. 39, 69, 99, 129, 169, 317.

One cast skin was collected on a tree near the bank of the Ohio river, near Cave-in-Rock, Ill., May 30, 1928, which cannot be placed definitely to species and therefore in this paper has been referred to as *Acroneuria* "sp. b." This may be the nymphal skin of a very light colored specimen of *A. abnormis*⁹ but it seems best to consider it as different until the North American *Acroneuria* fauna is better known. Since Cave-in-Rock is in extreme southeastern Illinois on the Ohio river, and similar nymphs have not been found in central or northern Illinois, it seems that the watershed of the Ohio holds the key to establishing the identity of this form.

In general structure the nymph is suggestive of *abnormis* as described in this paper. In fig. 317 is shown our idea of the appearance of the nymph based upon a cast skin. Detailed description of the nymph is left until its true status is known. The most important characters, in addition to the color pattern, fig. 317, are the absence of anal gills and occipital ridge. The mouthparts are as follows: labrum, fig. 39, mandibles, fig. 69, maxilla, fig. 99, labium, fig. 129, and submentum, fig. 169.

Exuvia.—Cave-in-Rock (Ohio r.): May 30, 1928, 1 ♂.

Neophasganophora Lestage

Lestage (1922) p. 101. New name for *Phasganophora* Klapalek. Genotype *Neophasganophora capitata* (Pictet) = *Perla capitata* Pictet, original designation.

The genus was first recognized by Klapalek (1921) and renamed *Neophasganophora* by Lestage (1922) because *Phasganophora* was pre-occupied. The single North American species belonging here, and type of the genus, has been placed in the genus *Perla* by American writers on this group of insects. The genus *Perla*, as pointed out elsewhere in this paper, has been a sort of dumping ground for various and often not closely related species. It is even doubtful whether *Perla* in its strictest sense occurs in North America.

According to Klapalek (1923), species belonging to this genus are found in northern Asia and North America. This latter author erred however in recognizing as separate species on the basis of poor color characters such forms as *annulipes* Hagen, *illustris* Banks and *flavescens* Walsh, which are synonyms of *capitata* Pictet or at least but color varieties of it. He also included *media* Walker and *fumosa* Banks. Needham and

⁹ Collection and rearing of material from Merrill, Wis. since writing this description appears to confirm this view.



Fig. 317.—*Acroneuria* sp. b, NYMPHAL MALE AS INDICATED BY EXUVIA.

Claassen (1925) show that the latter is a synonym of *immarginata* Say. *Media* and *immarginata* both belong in the genus *Togoperla*. Needham and Claassen (1925) recognize *Neophasganophora* and *Togoperla* as subgenera of *Perla* but as stated earlier I consider them genera.

My studies of extensive series of specimens, observations in the field and rearings have convinced me that the synonymy of *capitata* Pictet as given by Needham and Claassen (1925) is essentially correct and that this genus contains but a single described North American species.

***Neophasganophora capitata* (Pictet)**

Figs. 40, 70, 100, 130, 150, 207, 252, 318, 319, 320.

Perla capitata Pictet (1841) p. 214. Original description (♂).

Perla capitata Claassen (1931) p. 47. Nymphal description.

This large and common stonefly has been recorded from Canada and many states east of the Rocky mountains and is likely to be found in most of the others. It was first recorded from Illinois, near Rock Island, by Walsh (1862) under the name "*flavescens*, n. sp.," the type of which is now in the Museum of Comparative Zoology, Cambridge, Mass. The next record is that of Needham and Claassen (1925): "Illinois, Ottawa, July 2 (W. E. Howard)."

The adults are diurnal and thereby differ from the other Perlidae thus far discussed. On bright days they are active and congregate on vegetation near rivers in which the nymphs live. Mating takes place under such circumstances and a freshly emerged adult female frequently attracts many males. At evening I have observed females with attached egg masses flying over rapids below dams, obviously for the purpose of dropping the egg masses into the water. Occasional specimens are found at lights but according to my experience they are not attracted to lights at night in the same manner as *Acroneuria* and other genera and their presence there is apt to be accidental. The adults emerge at night from mature nymphs which crawl out of the water when ready to produce adults. They begin to emerge the last part of May and reach their maximum abundance during the first part of July, a seasonal range which makes them a member of the late spring and summer fauna. Our association of males and females is attested by rearings, mating pairs and field data.

Our specimens of both adults and nymphs come from the central and northern parts of the state. Absence of specimens from the southern end indicates that this species is uncommon or absent from the smaller, less permanent streams, although it should and probably does occur here and there along the Wabash, Ohio and Mississippi rivers. In localities of northern and central Illinois where *capitata* is abundant, the rivers have

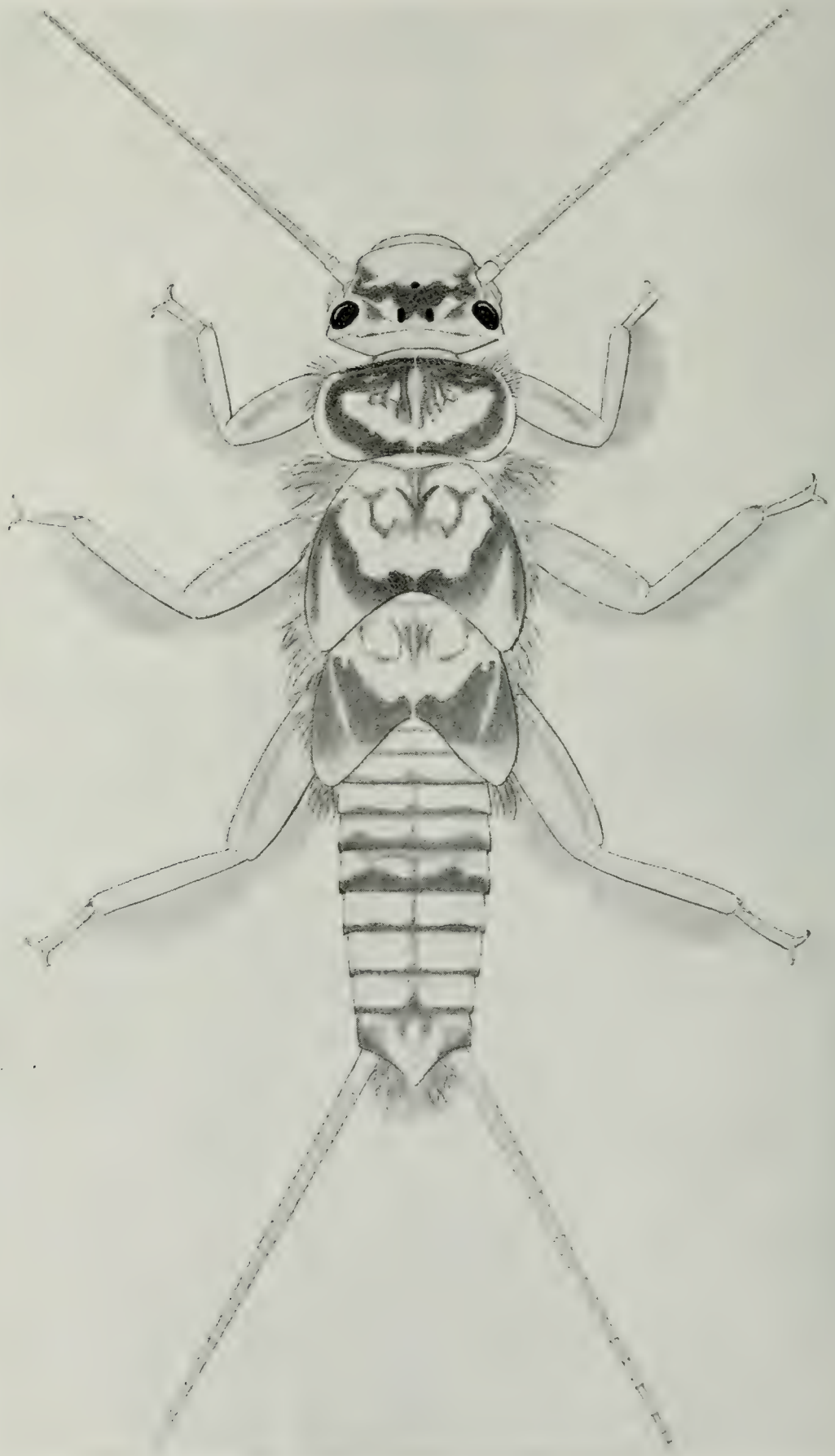


Fig. 318.—*Neophasganophora capitata*, NYMPHAL FEMALE. .

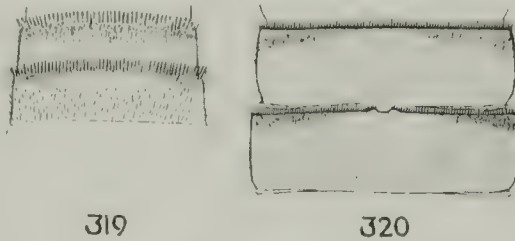
a rocky bed, the water is usually fairly clear and the current is swift. Rapids below dams are favorite haunts of the nymphs of this species and it is at such places in Illinois that they are most abundant.

The nymphs are carnivorous. Dissection of one *capitata* nymph collected in the Rock river, Rock Island, Ill., June 27, 1932, revealed an ingested, nearly full grown stonefly nymph so well preserved that its identification as *Isoperla bilineata* was possible. The life cycle of *capitata* undoubtedly takes two and possibly three years for completion.

The nymphs, fig. 318, are easily recognized by the structural characters utilized in the key to species and by their conspicuous color pattern. They have been described in detail by Claassen (1931). That author's association of nymph with adult is proved to be correct by our rearings.

Adults.—Homer (park): June 30, 1927, 2♂; June 1, 1931, 4♂. Kankakee: July 10, 1925, 1♂, 5♀. Keithsburg: June 9, 1932, 2♂, 5♀. Momence: July 17, 1914, 1♀. Oakwood: June 9, 1926, 3♀; July 6, 10, 1927, ♂♂, ♀♀; June 14, 1930, 3♂. Oregon: June 19–21, 1917, 4♀; July 9, 1925, 2♀; July 13, 1926, 1♀; July 18–19, 1927, ♂♂, ♀♀; May 21—June 28, 1928, 1♂, ♀♀; June 1929, 4♀; July 11, 1929, ♂♂, ♀♀; June 1930, 6♀; June 13, 1931, 7♂. Ottawa: June 12, 1901, 1♂. Pike: May 26, 1906, 4♂. Rockford: July 18, 1927, 1♂, 1♀; June 13, 1931, 36♂, 14♀. Rock Island: June 3, 30, 1930, ♀♀; June 8, 13, 24, 1931, 6♂, 2♀. Springfield: June 23–24, 1885, 1♀. Sterling: May 21, 1926, 1♂.

Nymphs.—Byron (Rock r.): May 17, 19, 23, 1927. Dixon (Rock r.): July 29, 1924; May 12, 22, 1925; Apr. 3, 1928. Dixon—Oregon (Rock r.): July 27, 1927. Grand Detour (Rock r.): May 25–29, 1927; July 2, 1932. Hillsdale (Rock cr.): July 21, 1925. Homer (Salt Fork r.): Nov. 5, 23, 1927; Apr. 18, 1931. Kankakee (Kankakee r.): June 12, 1931. Keithsburg (Mississippi r.): June 15, 1931; June 9, 1932, exuviae. Lyndon (Rock r.): July 8, 1925. Muncie (Stony cr.): Oct. 19, 1929. New Milford (Kishwaukee cr.): May 7, 1926. Oakwood (Middle Fork of Vermilion r., Salt Fork r.): Mar. 11, Oct. 11, 20, 27, Nov. 23, 1927; Nov. 2, 1929; May 3, 1931; May 11, 1932; Apr. 12, 1933. Oregon (Rock r.): May 25–26, July 5, 1927; Apr. 3, 1928; July 11, 1929; May 15, 1930; July 3, 1932. Ottawa (Illinois r.): July 21, 1901, exuviae. Paris—Chrisman: Mar. 9, 1928, exuvia. Pike: May 26, 1906, exuvia. Prophetstown (Rock r.): July 20, 1925. Rockford (Rock r.): Apr. 26, 1927. Rock Island (Rock r.): Apr. 2, 1928; June 3, 1930; Apr. 10, June 13, 1931; Apr. 27, May 9, 1932. Starved Rock (Illinois r.): June 13, 1901, exuvia. Sterling (Rock r.): Aug. 12, 1924; May 15, June 15–19, July 6, 1925; Apr. 3, 1928; Apr. 27, 1932. White Heath (San-



Figs. 319-320.—EIGHTH AND NINTH ABDOMINAL SEGMENTS OF *Neophasganophora capitata*, NYMPHS. This ubiquitous species illustrates the means of separating male and female nymphs by means of the continuous or interrupted posterior setal margins of eighth sternites. 319.—Male. 320.—Female.

gamon r.): May 13, 1928. Wilmington (Kankakee r.): Apr. 28, June 12, 1931.

Reared from nymphs.—Rockford (Rock r.): June 13, 1931. Rock Island (Rock r.): June 3, 1930; June 13, 1931.

Mating pair.—Oregon: June 27, 1928.

Togoperla Klapalek

Klapalek (1907) p. 19. Genotype *Perla limbata* Pictet = *Togoperla limbata* (Pictet), original designation.

Togoperla was proposed as a subgenus by Klapalek (1907) for certain Asiatic species of stoneflies and then given generic status by the same author (1923). It has been recognized as a subgenus containing North American representatives by Needham and Claassen (1925). Although differing from *Neophasganophora* in certain essential points it is most closely related to this genus, but is sufficiently distinct to entitle it to true generic status. Two species were placed by Needham and Claassen in the subgenus *Togoperla*,—*media* (Walker) and *immarginata* (Say).

One of these, *media*, has been found in Illinois and we have located a few specimens of a nymph of another species, not *immarginata*, apparently belonging in this genus which is not as yet associated with its adult.

KEY TO SPECIES

Nymphs

- Anterior and posterior margins of dorsum of head light and distinctly contrasting with dark areas, fig. 323. Light dorsal areas or spots in general distinctly contrasting with brown background. A few light spots on apical dorsal abdominal segments.....**sp. a**, p. 414¹⁰
- Anterior and posterior margins of dorsum of head not distinctly contrasting with brown background, fig. 321. Light dorsal areas poorly defined. Apical dorsal abdominal segments uniformly dark brown.....**media**, p. 412

Togoperla media (Walker)

Figs. 41, 71, 101, 131, 206, 254, 321, 322.

Perla media Walker (1852) p. 145. Original description.

Perla media Claassen (1931) p. 48. Nymphal description.

This species is a rarity in Illinois and our record is based upon the finding of a single nymph in the Mississippi river in extreme northwestern Illinois. Field studies made by the author in Wisconsin prove that *media* is a northern element in our stonefly fauna and that northwestern Illinois probably represents the extreme southern edge of its distribution in the central states.

¹⁰ The adult of *sp. a* is still unknown or at present not associated with the nymph and therefore no key can be given for the mature forms.



Fig. 321.—*Togoperla media*, NYMPHAL FEMALE.

Nymphal specimens collected by myself near Mercer, Wis., August 9, 1932, were found when dissected to contain remains of various insects. This confirms the statement of Claassen (1931) that the nymph is a carnivore. Size ranges of nymphal material from Wisconsin indicate certainly a two and possibly a three year life cycle. This means that only large or at least permanent streams can support this species. I have found the nymphs of *media* abundant in most northern streams of Wisconsin.

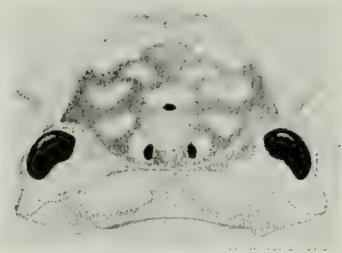


Fig. 322. — *Togoperla media*, DORSAL VIEW OF NYMPHAL HEAD SHOWING LIGHT FORM.

The nymphs taken in streams with clear water such as Trout river near Boulder Junction, Wis. have a lighter color than those from streams such as Teal creek, near Hayward, Wis. where the water is brownish.

The adults of *Togoperla media* are diurnal and like those of *Neophasganophora capitata* congregate on vegetation near rivers in which the nymphs live. Mating takes place during the day. The adults emerge from nymphs which leave the water at night. In Wisconsin the adults begin to appear during June, reach a maximum abundance in the northern counties during the first week in July, and by August have practically disappeared. The same general sequence may be expected in Illinois except that the species is rare and may appear earlier.

The nymphs, fig. 321, can be easily identified by the characters used in the key and have been described in detail by Claassen (1931). Our association of nymph and adults is based upon reared specimens and our association of the sexes upon similar nymphs, mating pairs and miscellaneous biological information. The most important morphological features of the adults and nymphs are shown in figs. 41, 71, 101, 131, 206, 254.

Nymph.—Savanna (beneath stones on a wing dam in the Mississippi r.): Sept. 10, 1932. Collected by T. H. Frison Jr.

Togoperla sp. a

Figs. 42, 72, 102, 132, 157, 323.

On wing dams in the Mississippi river near Alton and Grafton occurs a perlid nymph which probably belongs to this genus. This nymph was first collected during general biological work by Mr. R. E. Richardson in 1913 and a single specimen was again found in 1932 after diligent search by H. H. Ross and Carl O. Mohr. Several trips to this area to secure enough material for our rearing cages resulted only in the capture of this latter nymph. It is evident that this stonefly is a rarity in Illinois and the area from which it comes suggests it may be a more western species

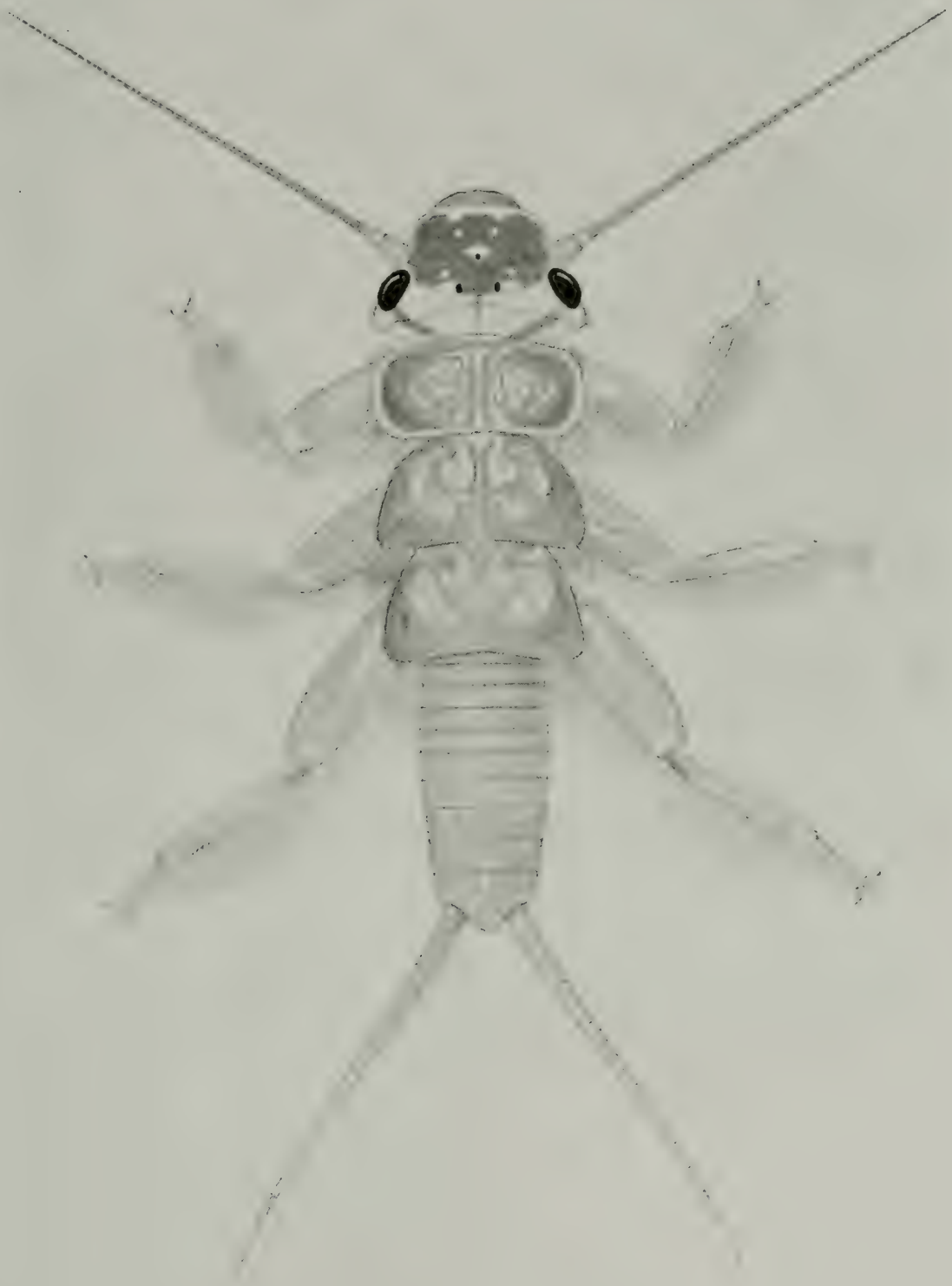


Fig. 323.—*Togoperla sp. a*, NYMPHAL MALE.

which is to be expected in the upper part of the Missouri river system. It may be that this is the nymph of *Perla kansensis* Banks which is known from Kansas.

The general appearance and color pattern of the nymph is shown in fig. 323. Its most important characters, aside from color pattern, are the placement of compound eyes on the side of the head near posterior margin, as in most Perlidae; three ocelli; presence of an occipital ridge; presence of thoracic gills; and the absence of anal gills. The mouthparts are as illustrated: labrum, fig. 42, mandibles, fig. 72, maxilla, fig. 102, labium, fig. 132, and submentum, fig. 157.

Nymphs.—Alton (Mississippi r.): Aug. 29, 1913. Grafton (Mississippi r.): Aug. 30, 1913; Sept. 8, 1932.

PERLODIDAE

This family is represented in Illinois by a single group of closely related species for which I am proposing the new generic name *Hydroperla*. Two other North American genera belonging to this family, *Perlodes* Banks and *Isogenus* Newman, are western or more northern in their distribution. These genera and certain others not found in North America constitute in my opinion a natural group of family rank which has been recognized in European literature by the name of *Perlodidae*. Needham and Claassen (1925) have included in the family Perlidae, along with many other genera, *Perlodes*, *Isogenus* and the species here assigned to my proposed new genus *Hydroperla*. The general characters of the adults and nymphs of the Perlodidae are essentially those given in the key to families, p. 333. Although Perlodidae and Chloroperlidae are closely related they may always be definitely separated by the presence or absence of a peculiar finger-like gill on the submentum of the nymphs, figs. 167, 168, or its remnant in the adults. This character requires at times some effort to see, but nevertheless is definite and of much value.

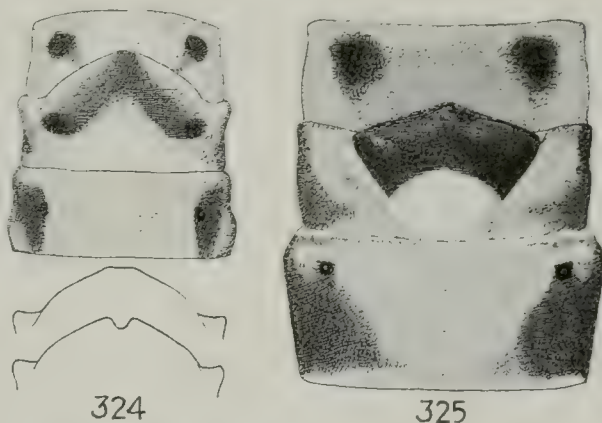
Needham and Claassen (1925) have also placed the species recorded here by the names of *Hydroperla crosbyi* (Needham and Claassen), *Hydroperla varians* (Walsh) and certain others under the subgeneric name of *Hemimelaena* Klapalek. The fact that Klapalek has placed *Hemimelaena* in Perlidae (*s. str.*) while recognizing the family Perlodidae leads me to believe that such North American species as *variens* are not comparable with the small *flaviventris* Pictet known from Portugal as a sole member of the genus *Hemimelaena* known to Klapalek. Furthermore, Klapalek (1912) has indicated by the placement of *postica* Walker in the genus *Isogenus* and subgenus *Isogenoides* (type *frontalis* Newman) that the true *postica* from North America, based upon the type, belongs in the family Perlodidae. It seems to me that the Illinois species *variens*, *crosbyi* and the one named *harti* in this paper, as well as some others not found in Illinois, constitute a natural group of generic status. None of the

generic or subgeneric names of Klapalek seem to embrace or include this group when it is properly understood or segregated and hence a new generic name is proposed.

Hydroperla—NEW GENUS

Type *Perla crosbyi* Needham and Claassen = *Hydroperla crosbyi* (Needham and Claassen).

The genus *Hydroperla* is apparently most closely related to *Isogenus*. In the adults it is characterized by the following: three ocelli; forewings without crossveins in anal area and with a series of median and cubital crossveins, fig. 183; first tarsal segment much shorter than third tarsal segment; cerci long and many segmented; prothorax about as wide as head; without nymphal gill remnants on sides or venter of thorax and abdomen; remnant of finger-like gills located near each side of outer basal corner of submentum; species dominantly black; of medium size with a body length usually more than 13 mm; males with tenth tergite deeply cleft; and females with a subgenital plate which usually is without any trace of a median notch, figs. 324, 325.



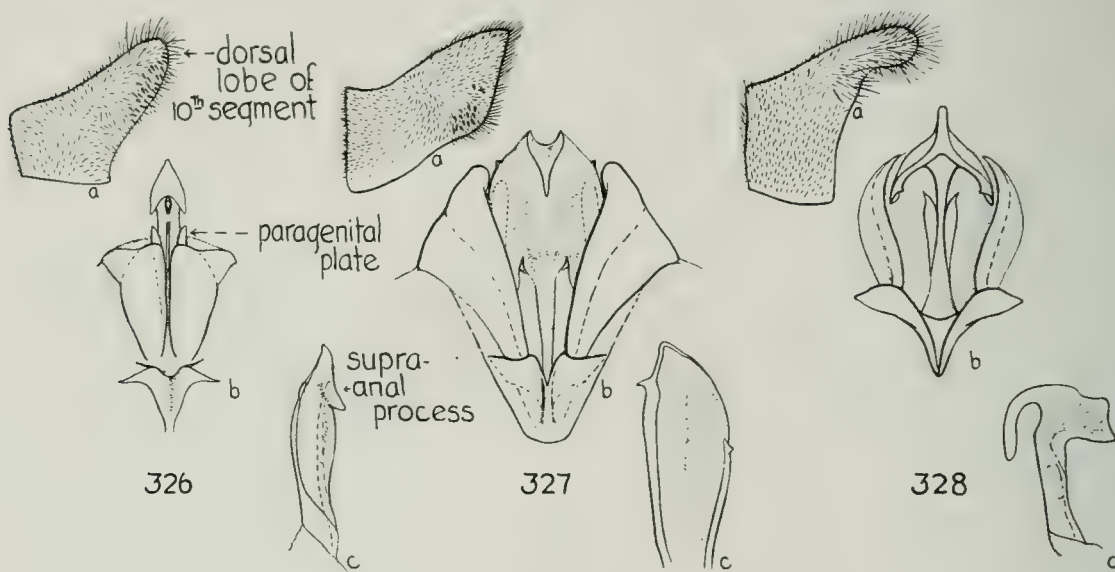
Figs. 324-325.—SEVENTH, EIGHTH AND NINTH ABDOMINAL STERNITES OF ADULT FEMALE, SHOWING SUBGENITAL PLATES. **324.**—*Hydroperla harti*, typical form; variations of subgenital plate in outline. **325.**—*H. crosbyi*.

Adults of *Hydroperla* may be separated from the other closely related genera belonging in Perlodidae as follows: 1.—From *Perlodes* by the absence of the network of irregular crossveins, figs. 183, 184, beyond the radial sector of the fore- and hind wings. 2.—From *Isogenus* in the females usually by the absence of a deep median notch on the posterior margin of the subgenital plate, figs. 324, 325, and in the males by the absence of dorsal humps on the apical abdominal tergites.

The genus is characterized in the nymphs by the following: three ocelli; labium with paraglossae extending forward much farther than the glossae, the glossae deeply inset below and between the paraglossae so as to appear almost as basal segments of them, figs. 133, 134; venter of thorax without distinct, large, overlapping, shieldlike plates; with small finger-like gills located near each side of outer basal angle of submentum, figs. 167, 168; absence of thoracic or abdominal gills; labrum as in figs.

43, 44, mandibles as in figs. 73, 74, and maxillae as in figs. 103, 104.

Claassen (1931) does not separate the nymphs of *Isogenus* from his so-called "gill-less *Perla*" but differentiates them from *Perlodes* by their lack of gills on the submentum. His placement of the nymph of *Isogenus* is apparently based upon a questionable identification or very poor specimens, as indicated by "*Isogenus colubrinus* (?) Hagen" and his statement



Figs. 326-328.—MALE GENITAL STRUCTURES OF THREE SPECIES OF *Hydroperla*. 326.—*H. harti*. 327.—*H. varians*. 328.—*H. crosbyi*.

that "the nymphs have been in alcohol so long that the bodies are rather badly shriveled." My adult specimens of *Isogenus colubrinus* Hagen and *Isogenus frontalis* Newman all show remnants of the finger-like nymphal gill near each side of the outer basal angle of the submentum and therefore I am positive that such gills are present in the nymphs and were overlooked by Claassen.

Lack of nymphal material of *Perlodes* and *Isogenus* prevents a full statement here of how they differ from *Hydroperla*. Presence of finger-like gills on the sides of at least some nymphs of *Perlodes* suggests this as one very valuable differential character. Until the nymphs of *Perlodes* and *Isogenus* are better known and have been reared no absolute characters for separation of these genera can be given.

KEY TO SPECIES

Adults

1. Tenth dorsal abdominal segment cleft for reception of supra-anal process; eighth ventral abdominal segment with posterior margin straight (males) . . . 2
2. Tenth dorsal abdominal segment not cleft; eighth ventral abdominal segment

HYDROPERLA—KEY TO SPECIES—CONT'D

- with posterior margin somewhat projecting over ninth segment, figs. 324, 325, (females).....3
2. Supra-anal process as in fig. 326.....**harti**, p. 423
 Supra-anal process as in fig. 327.....**varians**, p. 426¹¹
 Supra-anal process as in fig. 328.....**crosbyi**, p. 419
3. Dark, somewhat triangular markings on sides of ventral abdominal segments.
 Subgenital plate on eighth sternite as in fig. 325.....**crosbyi**, p. 419
 Dark markings on sides of ventral abdominal segments not triangular. Sub-
 genital plate on eighth sternite as in fig. 324.....**harti**, p. 423

Nymphs¹²

- General coloration dark, with dark areas on head and thorax very distinct. Dorsal segments of abdomen with basal portions dark and apical portions light so that abdomen appears banded transversely, fig. 329.....**crosbyi**, p. 419
- Pale nymphs with brownish areas on head and thorax not very distinct. Dorsal segments of abdomen with some brownish spots but no distinct dark bands on basal portions, fig. 330.....**harti**, p. 423

Hydroperla crosbyi (Needham and Claassen)

Figs. 43, 73, 103, 133, 168, 183, 325, 328, 329.

Perla crosbyi Needham and Claassen (1925) p. 79. Original description (♂).

The male holotype of this species, in the collection of Cornell university, has been studied by the writer through the courtesy of Professor Claassen. The peculiar bell shaped tip of the supra-anal process, fig. 328, of the male is quite distinctive and enables ready identification of this species. The typic specimens came from Missouri and our Illinois material presents the first records of this species since its description. I believe that it will eventually be found in many of the states in the Mississippi drainage.

We have collected this species only in central Illinois, but I believe that it will be found in medium or large streams in other sections. The adults are rarely found by the general collector. This is because of their seasonal timing, actual limitation in number and diurnal habits which eliminate their concentration at lights during the night. All but a few of our specimens have been secured by rearing the nymphs. During the day the adults, when not flying, rest or crawl about in places exposed to the warmth of the sun. So few individuals are produced per linear mile of stream and so many situations are suitable for resting places that

¹¹ The female of *varians* has not as yet been taken in Illinois and previous associations in literature may be in error.

¹² Nymph of *varians* not known.



Fig. 329.—*Hydroperla crosbyi*, NYMPHAL MALE.

their collection is mostly a matter of chance. The nymphs however, even though never abundant, concentrate in clumps of decaying leaves which are lodged in the water against stones or branches of trees, fig. 14, and examination of such places in late March or early April in central Illinois will certainly reveal some specimens. The nymphs are not partial to rapid water and are often found in slow, heavily silted streams in rich soil areas.

Our rearings and collections of adults in April and not later than the first of May prove *crobyi* to be a true member of the early spring fauna. Our association of nymphs and adults is based upon rearings, and association of the sexes upon mating pairs.

Dissection of one *crobyi* nymph collected in Catfish creek, near Brocton, Ill., March 28, 1932, revealed numerous chironomid nymphs and other insects in the alimentary tract, so that these nymphs are to be classed as carnivorous. Our collection of nymphs indicates that it takes about one year for the life cycle to be completed and that the most rapid growth of the nymphs occurs in February and March.

The following characterizes the previously undescribed nymph.

Nymphal male, fig. 329.—General ground color yellowish with conspicuous dark brown or black markings on dorsum as follows: most of central area of the head anterior to epicranial arms except for three yellowish spots and a more or less W shaped transverse band; transverse markings on posterior margin of head; posterior, anterior and part of lateral margins of prothorax; a series of markings on meso- and metanotum; a wide transverse band on anterior margin and a more slender transverse band or line on posterior margin of each abdominal tergite; and longitudinal stripes on femur.

Head with three ocelli forming a nearly equilateral triangle, lateral ocelli about on a line with anterior point of compound eyes and median ocellus about on line with middle of point of articulation with antennae. No occipital ridge. Posterior margin of compound eye with a row of short setae. Labrum, fig. 43, labium, fig. 133, maxilla, fig. 103, mandibles, fig. 73, and submentum, fig. 168, as illustrated.

Pronotum much broader than long; hind angles much rounded, front angles sharper; marginal groove rather weakly defined, particularly on lateral margins. Meso- and metanotum with wing pads well developed, those on mesonotum extending almost straight backward, and those on metanotum extending slightly outward as well.

Legs but slightly flattened; femora about twice as broad as tibiae and covered with numerous short stout setae except for a bare median longitudinal stripe; hind margins of femora, tibiae and tarsi with a fringe of long fine setae.

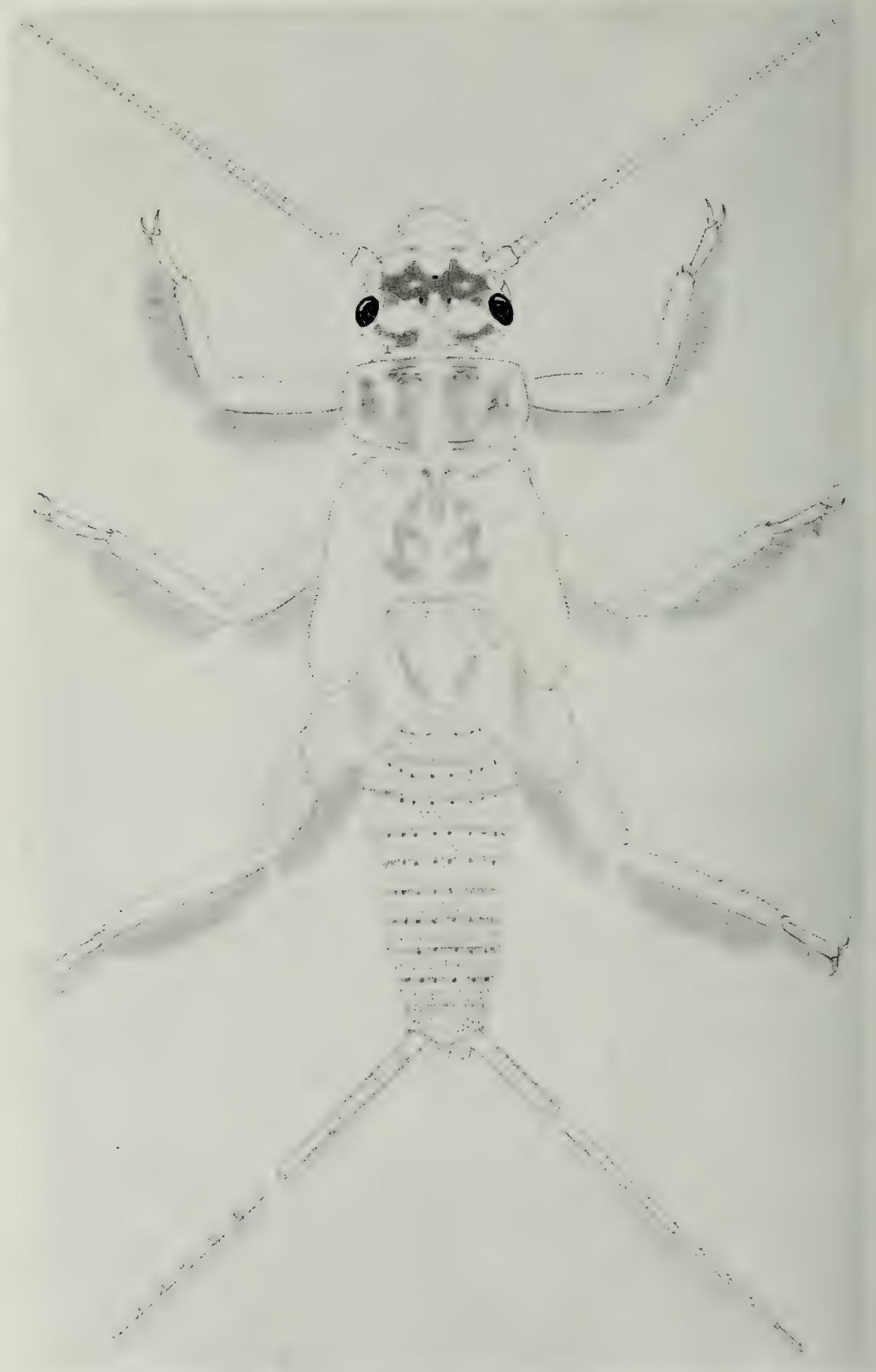


Fig. 330.—*Hydropsyche harti*, NYMPHAL MALE.

Abdomen shaped and marked as in fig. 329. Cerci about as long as abdomen, with 30 or more segments, segments progressively longer apically. Tenth tergite but slightly produced backwards on posterior margin. Eighth sternite with posterior margin almost straight and transverse setal fringe not interrupted.

Thoracic and abdominal gills absent. A small finger-like gill, fig. 168, at each outer posterior corner of submentum.

Mature specimens with a body length, exclusive of appendages, sometimes as much as 20 mm.

Nymphal female.—Similar to male in general color and most morphological details. Eighth abdominal sternite with row of setae on posterior margin interrupted in middle. Mature specimens average larger than males, with a body length up to 27 mm.

Adults.—Charleston: Apr. 11, 1931, 1♂. Havana: Apr. 21–24, 1898, 2♀. Urbana: May 1, 1927, 1♂; Apr. 11, 1928, 1♂.

Nymphs.—Brockton (Catfish cr.): Mar. 28, 1932. Charleston (Embarrass r.): Mar. 22, Apr. 2, 17, 1931; Mar. 28, 1932. Decatur (Stephens cr.): Mar. 27, 1931. Marshall (Big cr.): Feb. 27, 1932. Oakwood (Salt Fork r.): Mar. 4, 1927. Shelbyville (Kaskaskia r.): Apr. 10, 1932. W. Union (Mill cr.): Feb. 27, 1932.

Reared from nymphs.—Charleston: Apr. 11, 17, 24, 1931, 12♂, 6♀.

Mating pair.—Charleston: Apr. 17, 1931.

***Hydroperla harti* — NEW SPECIES**

Figs. 24, 44, 74, 104, 134, 167, 324, 326, 330.

The distribution in Illinois of this new species is peculiar in that all our adults, nymphs and nymphal cast skins have come from the Mississippi river or from the Rock river near its confluence with the Mississippi. Our collecting in central eastern Illinois is sufficiently quantitative and qualitative to indicate that *harti* is either a great rarity in that part of the state or is absent. Its distribution suggests that there is probably some idiosyncrasy in the life history of this species which restricts it to very large rivers. Along the Mississippi in southern Illinois it is as common as is *crosbyi* in central Illinois.

Our collections of adults and rearings show that *harti* is a true member of the spring fauna. The adults, like *crosbyi*, are diurnal and a favorite resting place during the day is pier, wing dam or bridge piling in the Mississippi river or vegetation near the shore. It is on such structures in the river also that the cast skins of the nymphs are found in numbers. Mating takes place during the day. The largest number of adults taken at one place and time was near Ivy Landing, Ill., May 17, 1932, where these stoneflies were active on vegetation near the river. *Perla fugitans* Needham and Claassen may be closely related to this species.

Due to scarcity of material I have not dissected a nymph but judging from the mouthparts I am confident that it is carnivorous like its close relative *crosbyi*.

Male.—Length to apex of wings 15 mm.; length to apex of abdomen 12 mm. General dorsal color dark brown or black. Yellowish dorsal areas as follows: a band on extreme posterior margin of head, narrow area around compound eyes, and an arm extending forward from posterior band into ocellar area; a median longitudinal stripe, broad on anterior pronotal flange and on posterior half of pronotum, narrow between these two areas; a median longitudinal stripe on mesonotum; apical abdominal tergite and extreme base of cerci. General ventral color yellow with median and lateral dark areas on thoracic segments and with broad dark bands on abdominal sternites except first which has spots, and last sternite which is entirely yellow but for small dark spots near base of cerci. Antennae, legs and cerci except extreme base are essentially dark brown or black.

Head but slightly wider through compound eyes than pronotum; ocelli nearly forming an equilateral triangle, lateral ocelli about on a line with middle of compound eyes, median ocellus about on a line with posterior point of articulation of antennae. Submentum with remnants of the finger-like nymphal gills at outer posterior angle. Antennae with 40 or more segments, basal segments wider than long, middle and apical segments longer than wide.

Pronotum approximately quadrangular, much broader than long, slightly wider at posterior margin than on anterior margin; front angles rather sharp, rear angles slightly rounded; pronotal flange well developed on anterior margin but weakly so on sides and on posterior margin; a rather indistinct pattern of raised rugosities on surface.

Legs almost uniformly dark brown or black; second tarsal segment much shorter than first, the first much shorter than third.

Wings long, extending beyond tip of abdomen, up to 14 mm. in length; membrane dull hyaline, veins very dark and contrasting; venation slightly variable but essentially as for *crosbyi*, fig. 183.

Abdomen with dorsal segments one to nine without special structures; tenth tergite cleft, with paragenital plates, supra-anal process and apical lobes as in fig. 326. Cerci with 30 or more segments, basal segments broader than long, middle and apical segments much longer than broad.

Female.—Length to apex of wings 21 mm.; length to apex of abdomen 15 mm. Head, thorax, abdomen and appendages in general similar to those of male. Differs from male as follows: basal abdominal segments often slightly lighter than those of middle area, ninth abdominal tergite largely yellow; tenth abdominal

tergite not cleft but slightly rounded behind; abdominal sternites one to eight mostly yellowish, with more or less quadrate spots on lateral margins; eighth abdominal sternite with a posteriorly protruding and somewhat triangular subgenital plate overlapping basal portion of ninth sternite, fig. 324; subgenital plate dark brown or black; a more or less rounded spot on each lateral portion of ninth sternite.

Nymphal male, fig. 330.—General ground color pale whitish yellow. Dorsum with some brownish, often suffused markings on head and thorax; longitudinal rows of small distinct brownish spots on abdomen; the area anterior of epicranial arms on the head is the darkest of the brown areas, followed in intensity by markings on pronotum.

Head with three ocelli nearly forming an equilateral triangle; lateral ocelli about on a line with anterior point of compound eyes and median ocellus about on line with middle of point of articulation with antennae. No occipital ridge. Posterior margin of compound eye with a row of some short setae. Labrum, fig. 44, labium, fig. 134, maxilla, fig. 104, mandibles, fig. 74, and submentum, fig. 167, as illustrated.

Pronotum much broader than long; hind angles much rounded, front angles sharper; marginal groove rather weakly defined, particularly on lateral margins. Meso- and metanotum with wing pads well developed, those on mesonotum extending almost straight backward, and those on metanotum extending slightly outward as well.

Legs but slightly flattened; femora about twice as broad as tibiae and with only a few short stout setae; hind margins of femora, tibiae and tarsi with a fringe of long fine setae.

Abdomen marked as in fig. 330. Cerci longer than abdomen, with over 30 segments; segments progressively longer apically. Tenth tergite slightly produced backwards on posterior margin. Eighth sternite with posterior margin almost straight and transverse setal fringe not interrupted.

Thoracic and abdominal gills absent. A small finger-like gill, fig. 167, at each outer posterior corner of submentum.

Mature specimens with a body length, exclusive of appendages, of 13 mm.

Nymphal female.—Known to me only from cast skins which average larger than the males and have the row of setae on the posterior margin of the eighth abdominal sternite interrupted in the middle. Color pattern and other features are as in the male.

Holotype, male.—Ivy Landing, Ill. (near Mississippi r.): May 17, 1932. Collected by H. H. Ross and C. O. Mohr.

Allotype, female.—Collected *in coitu* with holotype.

Paratypes.—Chester: May 11, 16, 1932, 1♂, 4♀. Fountain Bluff: Apr. 21, 1914, 2♂; May 12–15, 1932, 4♀. Grafton: May 10, 1932, 1♂. Ivy Landing: May 17, 1932, 3♂, 9♀. Rock Island: May 3, 1931, 2♂, 1♀.

Tiptonville, Tenn. (Reelfoot lake): Mar. 28, 1932, 1♂; Apr. 2, 1934, 5♂, 8♀.

Nymphs.—Alton (Mississippi r.): May 18, 1932, exuvia. Chester (Mississippi r.): May 11, 16, 1932, exuviae. Fountain Bluff (Mississippi r.): May 12–15, 1932, exuviae. Grafton: May 19, 1932, exuvia. Keithsburg: June 14, 1932, exuvia. Rock Island (Rock r.): Apr. 10, 1931; Mar. 2, 1932.

Reared from nymphs.—Rock Island: May 3, 1931.

***Hydroperla varians* (Walsh)**

Fig. 327.

Perla varians Walsh (1863) p. 364. Original description (♂, ♀).

This species was described by Walsh from specimens taken near Rock Island, Ill., and Dr. Banks has stated to me in a letter that the type is now in the collection of the Museum of Comparative Zoology, Cambridge, Mass. An autotypic male specimen, obtained from the institution just mentioned, is now in the SURVEY collection and bears the data "*Perla varians*, Rock Island, 1863." I am basing my concept of *varians* upon the characters of this specimen. The only other specimen we have of this species, also a male, comes from far to the south on the Ohio river at Golconda, Ill., April 19, 1914.

Study of the male in our collection, named by Walsh, shows that *varians* differs from both *crobyi* and *harti* in the shape of the supra-anal process and in certain other structures, fig. 327. The Illinois males of *Hydroperla* are easy to separate on the basis of the genital structures but other characters are unreliable or nearly nonexistent. Walsh described the female as well as the male but I am not certain whether his association was correct because *harti* also occurs at Rock Island and might have been mixed with his *varians*. His description of the female, that "the seventh abdominal segment is prolonged laterally much beyond the other abdominal segments, so as to partially cover the base of the antepenultimate ventral" is suggestive of *harti*.

It is also possible that Walsh's series of *varians* contained males of *varians* as here used and also of *harti*. The drawing of Needham and Claassen (1925) of the male of *varians* does not bring out clearly the details of the supra-anal process, but in general it is very suggestive of what I am calling *harti*.

Evidently *varians* is uncommon in Illinois and I have not located a nymph which might be this species. Our specimen from Golconda was collected April 19, a good indication that *varians* is a true member of the spring fauna as are the other *Hydroperla*. No doubt its habits are very similar to those of *crobyi* and *harti*.

It should be stated here that Needham and Claassen (1925) have

recorded *varians* from Illinois (based upon Walsh's record), Indiana, Kansas, Michigan, Minnesota and Wisconsin. I have studied some of these specimens and the ones studied do not agree with what I am calling *varians* based upon the autotypic male in our collection. Further, I believe that some of these specimens which have been recorded as *varians* are the same species as specimens recorded under the name of *postica* Walker. Certain specimens named and recorded by Needham and Claassen both as *varians* and *postica* have a much more slender supra-anal process than *harti* and it is possible that their plate 17, fig. 12, is an illustration of this species, for which I am holding the name of *postica*. Needham and Claassen do not figure a male of *postica*.

Apparently, then, there is a species of *Hydroperla* not as yet found in Illinois which can be associated with the name *postica*, although just what Walker had when he described *postica* is somewhat doubtful. The type of *varians* at Cambridge, or the specimen selected as a lectotype in the Cambridge series, needs to be restudied in the light of present knowledge to settle the use of the name *varians*, and I regret not having had such an opportunity.

My rearings and mating pairs have definitely linked the males and females of two species of *Hydroperla*, *crobyi* and *harti*. Heretofore no reliable basis has existed for the assignment of females belonging to this complex of species to any male. This alone is sufficient to explain wrong associations of sexes or misidentifications in the past.

CHLOROPERLIDAE

Although this family has been recognized by many European students of stoneflies, it has not been accepted in American systems of classification. I consider that *Chloroperla* Newman, *Alloperla* Banks, *Isoperla* Banks (*s. lat.*), *Paraperla* Banks and *Kathroperla* Banks are the North American genera comprising this family.

Here probably belong, also, certain species which Needham and Claassen (1925) have placed under the subgenus *Hemimelaena*. As mentioned before, I am doubtful about the occurrence of the true *Hemimelaena* in this country and have placed in Perlodidae, under the genus *Hydroperla*, several species which have been assigned to *Hemimelaena* and which I feel certain belong to another line of descent. Future studies of both adults and nymphs are needed before the status of several of the species placed in *Hemimelaena* by Needham and Claassen can be determined satisfactorily. *Perla duplicata* Banks, one of two species placed by Needham

and Claassen under their new subgeneric name *Diploperla*, I am placing in *Isoperla* (*s. lat.*).

That *Diploperla*, as represented by the species *duplicata* in this report, is not a true *Isoperla* is evident from a study of either adults or nymphs. From the standpoint of identification however it can best be treated at the present time as a member of *Isoperla* (*s. lat.*).

The genus *Isoperla* as used in this paper includes certain species for which Needham and Claassen (1925) have proposed the generic name of *Clioperla*. In my studies of the adults and nymphs of Illinois species and of other material I have found it impossible to make a clear or absolute distinction between *Isoperla* and *Clioperla*. *Isoperla* is supposedly characterized from the standpoint of wing venation by the absence of intercubital crossveins, and *Clioperla* by their presence. This is an exceedingly variable character in some of the species concerned. Even in *Isoperla bilineata*, the type of the genus *Isoperla*, my tabulations show that about one-third of the Illinois specimens are likely to have an intercubital crossvein in one or both wings.

Since Claassen (1931) has noted a difference in the shape of the lacinia in the nymphs of the species he placed as *Isoperla* and *Clioperla*, I would be tempted to hold *Clioperla* as a valid genus if it were not for two reasons. In the first place I can find no constant distinctive and workable characters except size and color by which to separate the adults of these two groups as at present defined. Secondly, within the group of species placed by Needham and Claassen in *Isoperla* and those described in this paper we find nymphs with such diversified lacinia that they are as well entitled to generic status on this basis as are the nymphs which have been placed in *Clioperla*. In other words, if *Clioperla* is to be recognized as a genus it would be equally proper to establish several additional genera, easily differentiated as nymphs but very hard to define as adults. The characters shown by the lacinia of some of the nymphs unfortunately do not carry over.

Whether the apical segments of the maxillary and labial palpi are slender or not has also been used for separating nymphs of *Clioperla* and *Isoperla*. Some of the isoperlid species do have more slender palpi than others but I have been unable to separate the Illinois isoperlids into groups on this basis so that the resulting groups would be in harmony with other evidences of relationships.

In view of the present status of our knowledge of the North American *Isoperla* (*s. lat.*) in general it has seemed best to follow a conservative course in the present study based upon the Illinois fauna and to recognize the smaller complexes (*Clioperla*, *Diploperla*, *Isoperla s. str.*, etc.) of

natural aggregates of species within *Isoperla* (*s. lat.*) as subgenera. Perhaps future studies covering all the North American *Isoperla* (*s. lat.*) will shed such new light upon this group that it will be found necessary as well as practical to elevate these subgenera to generic status or else to sink them entirely. It seems to me that my difficulty in not being able to formulate a generic classification upon the basis of the adults which will hold for the nymphs, or *vice versa*—in spite of the heterogeneous appearance, size and color of the species lumped in *Isoperla* (*s. lat.*)—is indicative that the species of Chloroperlidae, particularly isoperlid forms, exhibit a group in a state of active evolution.

The adults are characterized by the absence of crossveins in the anal area of the forewings, the presence of a series of median and cubital crossveins in the forewing, presence of long and many segmented cerci, short first tarsal segment in comparison with third tarsal segment, and the absence of any remnants of nymphal gills. The combination of the complete absence of all types of gills with possession of mouthparts in which the paraglossae of the labium extends forward much farther than the glossae, fig. 135, especially separates the nymphs of Chloroperlidae from other families.

Of the genera which I consider as belonging to Chloroperlidae, only *Isoperla* (*s. lat.*) and *Chloroperla* have been found in Illinois.

KEY TO GENERA

Adults

- Hind wing without a folded anal area, fig. 187.....*Chloroperla*, p. 429
Hind wing with a folded anal area, fig. 188.....*Isoperla* (*s. lat.*), p. 431

Nymphs

- Wing pads with lateral margins broadly rounded, fig. 331....*Chloroperla*, p. 429
Wing pads with lateral margins more straight, figs. 339, 344.. *Isoperla* (*s. lat.*), p. 431

Chloroperla Newman

Newman (1836) p. 501. Genotype *Chloroperla apicalis* Newman, subsequent designation of Enderlein (1909).

In Europe the name of *Isopteryx* is still used for this genus but Banks (1906a) has clearly shown that *Chloroperla* is the generic name to be used for those species possessing the characteristics of *cydippe*. Absence of a folded anal field in the hind wing is a reliable character for recognition of the group.

According to Needham and Claassen (1925) this genus contains but one North American species.

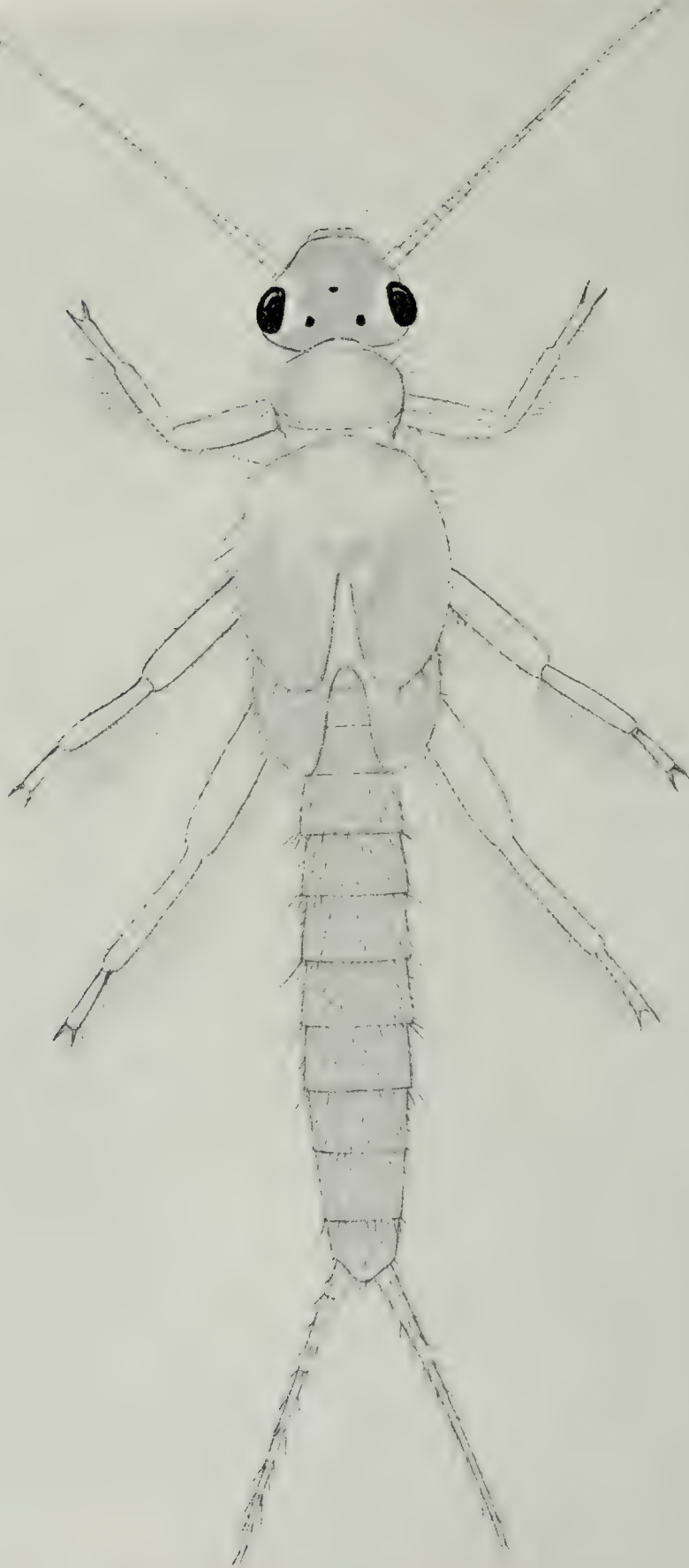


Fig. 331.—*Chloroperla cydippe*, NYMPHAL FEMALE.

Chloroperla cydippe Newman

Figs. 45, 75, 105, 135, 185, 187, 191, 232, **331**.

Chloroperla cydippe Newman (1839) p. 88. Original description.

Chloroperla cydippe Claassen (1931) p. 63. Nymphal description.

This species has been recorded from near Rock Island by Walsh (1862) under the name of *Isopteryx cydippe*. Strangely, it has not been encountered again in this state during our eight years of field work on stoneflies. Since Walsh's identification of this species was checked by Hagen, as indicated by the exclamation point after the name in his report, and since Hagen unquestionably knew *cydippe*, this record must be accepted. However, we have found this species in abundance in the Wabash watershed of Indiana, near the Illinois border. No doubt it will sometime again be found in this state.

The records given in literature for this species are mostly from states east of the Mississippi river. No doubt it will eventually be found in many states east of the Rocky mountains. Our observations concerning this species at Turkey Run state park, Ind. indicate that the adult maximum abundance comes about the middle of May. The nymphs are herbivorous and occur in masses of leaves lodged in the water of small streams. We have reared the adults at our Charleston, Ill. station from nymphs taken in Indiana.

The adults have been well described by previous writers. Their distinctive features from the standpoint of identification are given in the key to adults of Chloroperlidae and in figs. 191, 232. The nymph, fig. 331, has been described by Claassen (1931). Its most important morphological features, aside from general appearance and absence of gills, are the broadly rounded lateral margins of the wing pads and the shape of the mouthparts, figs. 45, 75, 105, 135.

Isoperla Banks

Banks (1906a) p. 175. Genotype *Perla bilineata* Say = *Isoperla bilineata* (Say), original designation.

The generic name of *Isoperla* was proposed by Banks (1906a) for part of the aggregate of species left without a name when *Isopteryx* of European authors was shown to be equivalent to *Chloroperla*, the latter having priority. The other part of this aggregate was named by Banks at the same time as *Alloperla*.

I am using *Isoperla* in a broad sense, as previously indicated, because of the impossibility of making definite separations at this time of those small natural aggregates which have been proposed as genera or subgenera

and still others which have not been named but exist as shown by my studies. I am referring here to such groups as *Clioperla*, *Diploperla* and others unnamed. A thorough study of the North American Chloroperlidae, both adult and nymphs, will need to be made before these divisions can be properly evaluated as to genera or subgenera. As here used in its broad sense, *Isoperla* is quite generally distributed over North America.

The *Isoperla* of this state evidently require one year for completion of their life cycle. Of the nine species included here I have had opportunity to study seven in the field. Most of these are diurnal and may be collected upon vegetation or other objects near the streams inhabited by the nymphs. *Isoperla bilineata* and probably *richardsoni* are more nocturnal and come to lights in large numbers. The fact that some species are diurnal and others nocturnal is good evidence that *Isoperla* as used here is composed of two or more rather separate elements.

Further evidence that the *Isoperla* of this paper include diverse forms are the feeding habits and mandibles of the adults. I have observed adults of *minuta*, a diurnal species, feeding upon pollen, and examination of its mouthparts reveals well developed and sclerotized mandibles. Another diurnal species, *decepta*, likewise has such mandibles but I have not observed the adults feeding. The mandibles of the adults of *bilineata*, *confusa*, *conspicua*, *duplicata*, *mohri* and *richardsoni*, on the contrary, are more flabby and do not impress me as being functional. Some of these are diurnal and others are nocturnal.

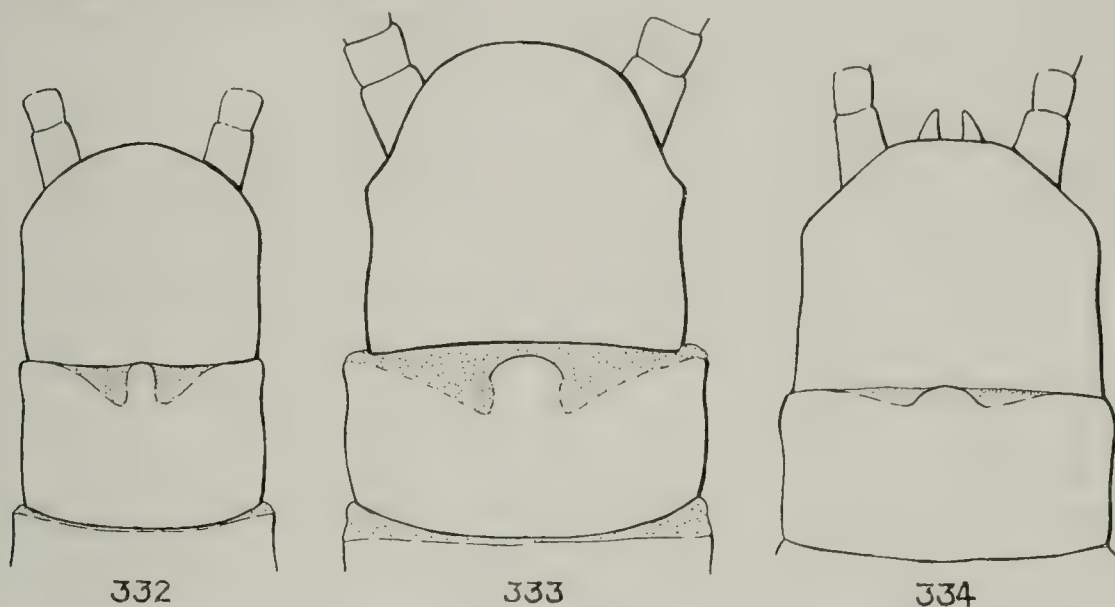
The nymphs also show cause for believing that the genus is at present an aggregate. Variation in their choice of stream is prominent. *Bilineata* and *richardsoni* apparently prefer the largest rivers, *confusa* streams of medium size, and *decepta*, *duplicata*, *minuta* and *mohri* very small streams or brooks.

The food habits of the nymphs, which I suspect are variable but which need further investigation, are another indication. Claassen (1931) states that the structure of mouthparts of the nymphs of *Clioperla* (*Isoperla* as used here) "indicates that they are carnivorous," and that nymphs of *Isoperla* "are carnivorous, but in their younger stages one sometimes finds plant remains, such as diatoms and algae, in their digestive tract." I have examined quite a few nymphs of *Isoperla bilineata* and *minuta* without finding any insect remains but have found such remains in the nymphs of *duplicata*, *mohri* and *confusa*. In addition our field notes record the collection of a nymph of *Isoperla decepta*, and at another time a nymph of *richardsoni*, with a half eaten chironomid larva in its mouth.

Variations in feeding habits are likewise indicated by differences in structure of the nymphal lacinia. Probably those species like *bilineata*

which at times are very abundant lean toward the herbivorous habit, whereas the larger and less abundant species like *confusa* and *duplicata* are more pronounced carnivores.

There is a possibility that one or more of the new species placed in this genus have been previously described. These relationships cannot be definitely determined from literature at this time and need to await rearings of adults from nymphs and correct associations of males and females in other parts of the country.



Figs. 332-334.—VENTRAL VIEW OF TERMINAL ABDOMINAL SEGMENTS OF ADULT MALE OF *Isoperla*. Note differences in shape of median lobe on posterior margin of eighth sternite. 332.—*I. decepta*. 333.—*I. mohri*. 334.—*I. bilineata*.

Walsh (1862) has described a "female (?) specimen" from near Rock Island under the name of "*Chloroperla nana*, n. sp." This species has never been satisfactorily placed. It was accidentally omitted from consideration by Needham and Claassen (1925) but subsequently listed as unrecognizable by Claassen (1928). Our studies of the Illinois stoneflies have failed to clear the mystery concerning this species. The description indicates a very small dark species, which might be *Isoperla minuta* Banks. It does not however have the hyaline streaks on the wings entirely absent as stated in the original description and it seems strange that Walsh would overlook the distinctive shape of the subgenital plate of his specimen if it were a female. Furthermore, we have not as yet found *minuta* in the vicinity of Rock Island although it is very common in central Illinois. Walsh's uncertainty about the sex of *nana* indicates that his type was a male if it is the same species as *minuta*. Perhaps after the *Isoperla* fauna of the central states is better known it will be advisable to sink *minuta* as a synonym of *nana*. Unfortunately the type of the latter is not in existence.

KEY TO SPECIES

Adults¹³

1. Ninth ventral abdominal segment much produced posteriorly and recurved upward so that tenth ventral abdominal segment is mostly or entirely concealed, fig. 334. Eighth ventral abdominal segment slightly produced or with a small lobe in middle of posterior margin, figs. 332-334, (males). 2
 Ninth ventral abdominal segment poorly or not at all produced posteriorly, and tenth ventral abdominal segment always visible. Eighth ventral abdominal segment without a small lobe in middle of posterior margin; posterior margin either broadly transverse, fig. 251, or strongly produced as a subgenital plate, fig. 237, (females).....7
2. Seventh ventral abdominal segment with middle of posterior margin distinctly produced, fig. 341.....**duplicata**, p. 449
 Seventh ventral abdominal segment with posterior margin of segment straight. 3
3. Dorsal, ventral and lateral surfaces of abdominal segments uniformly dark brown. A small species usually shorter than 7 mm.....**minuta**, p. 453
 Dorsum and venter of abdomen mostly yellow, yellowish brown or whitish green. In some species with dark lateral marking strongly contrasting with remainder of abdomen. Small to medium sized species ranging from 8 mm. to 16 mm. long.....4
4. Species with contrasting body colors of yellow and black or brown. Veins of wings all dark and strongly contrasting with membrane of interspaces. Cerci dark.....5
 Species yellowish or whitish green. Veins of wings lighter and less contrasting. Cerci pale.....6
5. Area between ocelli completely dark. Patch of small spines on posterior portion of ninth dorsal abdominal segment, fig. 205. Lobe in middle of posterior portion of eighth ventral abdominal segment broad, similar to fig. 334. Medium sized species, at least 13 mm. in body length....**confusa**, p. 441
 Area between ocelli not completely dark. Without a patch of small spines on posterior portion of ninth dorsal abdominal segment, fig. 193. Lobe in middle of posterior portion of eighth ventral abdominal segment narrower and more sharply defined, fig. 333. Small species, less than 10 mm. in body length.....**mohri**, p. 455
6. Median and lateral ocelli connected by a dark line making a V shaped outline.....**bilineata**, p. 437; **richardsoni**, p. 459¹⁴
 Median and lateral ocelli not connected by a dark line.....**decepta**, p. 447
7. Legs dominantly dark brown or black.....8
 Legs dominantly pale yellow or whitish green.....12
8. Dorsal, ventral and lateral surfaces of abdominal segments uniformly dark brown. Crossveins in costal margin of forewing between humeral crossvein and end of subcosta usually entirely lacking, rarely one. Costal margin of forewing pale and contrasting with remaining fuscate portion

¹³ The male of *conspicua* is not known and *elio* is not included in the adult key under either sex because of lack of specimens.

¹⁴ I have been unable to separate the males of these two species satisfactorily in the key. See discussion under *richardsoni*.

KEY TO SPECIES—ISOPERLA—CONT'D

- of wing. Small species, usually shorter than 8 mm. in body length; subgenital plate as in fig. 234.....*minuta*, p. 453
- Dorsum and venter of abdomen mostly yellow or yellowish brown; in most species with dark lateral markings contrasting with remainder of abdomen. Small to medium sized species ranging from 8 mm. to 17 mm. in body length.....9
9. Subgenital plate extending entirely across ninth sternite, fig. 249.....*duplicata*, p. 449
- Subgenital plate not extending so far posteriorly.....10
10. Subgenital plate deeply notched in middle of posterior margin, fig. 239....*conspicua*, p. 449
- Subgenital plate not deeply notched in middle of posterior margin.....11
11. Subgenital plate weakly rounded on posterior margin and but slightly produced over ninth sternite, fig. 251. Area between ocelli entirely dark. Medium sized species with a body length exceeding 13 mm. .*confusa*, p. 441
- Subgenital plate well rounded on posterior margin and considerably produced over ninth sternite, fig. 238. Area between ocelli not entirely dark. Small species with a body length less than 10 mm.....*mohri*, p. 455
12. Median and lateral ocelli connected by a dark line making a V shaped outline.....13
- Median and lateral ocelli not connected by a dark line.....*decepta*, p. 447
13. Subgenital plate somewhat triangular and much produced over ninth sternite, figs. 236, 237.....*bilineata*, p. 437
- Subgenital plate more rounded and but slightly produced over ninth sternite, fig. 235.....*richardsoni*, p. 459

Nymphs

1. Dorsal abdominal segments uniform, brownish except for a few small light spots, fig. 338.....*confusa*, p. 441
- Dorsal abdominal segments with alternating transverse or longitudinal light and dark stripes or bands.....2
2. Dorsal abdominal segments with transverse markings, figs. 337, 340. Full grown nymphs medium to large, 13 to 20 mm. body length.....3
- Dorsal abdominal segments with longitudinal markings, figs. 335, 342. Full grown nymphs of small to medium size, 6 to 13 mm. body length.....4
3. Anterior margins of dorsal abdominal segments dark, posterior margins light, fig. 340. Lacinia of maxilla much narrower where teeth begin than at base, which is much swollen, fig. 110.....*duplicata*, p. 449
- Anterior and posterior margins of dorsal abdominal segments dark, middle portion light, fig. 337. Lacinia of maxilla almost as wide where teeth begin as at base, fig. 107.....*clio*, p. 439
4. Head with dark area extending back from median to lateral ocelli not quadrate; light area in center of ocellar triangle large, figs. 335, 344. Lacinia with two long conspicuous teeth at tip, figs. 106, 113.....5
- Head with dark area extending back from median to lateral ocelli almost quadrate; light area in its center or center of ocellar triangle small, figs. 339,

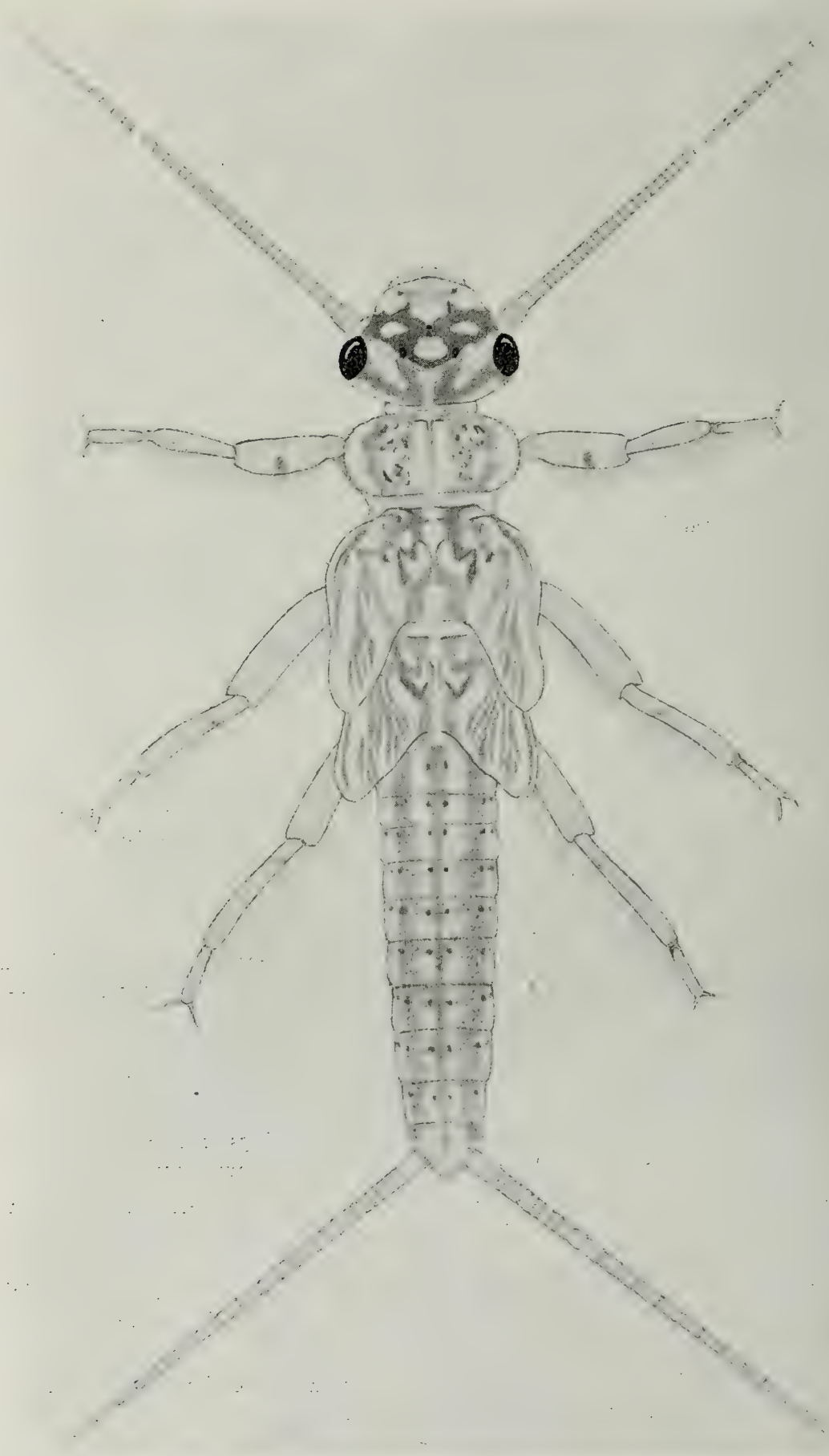


Fig. 335.—*Isoperla bilineata*, NYMPHAL FEMALE.

ISOPERLA—KEY TO SPECIES—CONCL'D

- 342, 343. Lacinia with one, figs. 111, 112, or no, fig. 109, long conspicuous tooth at tip.....6
5. Head with light areas between compound eyes and adjacent to ocelli usually forming large detached spots, fig. 335. Three longitudinal dark stripes on dorsum of abdomen indistinct, fig. 335. Lacinia with inner margin lined with a row of long stiff setae, fig. 106.....**bilineata**, p. 437
- Head with light areas between compound eyes and adjacent to ocelli more confluent, fig. 344. Three longitudinal dark stripes on dorsum of abdomen more distinct, fig. 344. Lacinia with a tuft of long setae grouped just below smaller tooth and without a conspicuous row of long stiff setae on inner margin, fig. 113.....**richardsoni**, p. 459
6. Dorsum of abdomen with two distinct dark longitudinal stripes upon an almost uniformly light background, fig. 343. Lacinia with one long conspicuous tooth at apex, fig. 112. Mandibles deeply notched at tips, fig. 82....
.....**mohri**, p. 455
- Dorsum of abdomen with two dark longitudinal stripes upon a somewhat suffused background which is dotted with numerous freckle-like spots, figs. 339, 342. Lacinia with one, fig. 111, or no, fig. 109, conspicuous tooth at apex. Mandibles less deeply notched at tips, figs. 79, 81.....7
7. Lacinia with one long tooth at apex, fig. 111.....**minuta**, p. 453
- Lacinia without a long tooth at apex; instead with several short, blunt scraper-like processes at apex, fig. 109.....**decepta**, p. 447

***Isoperla bilineata* (Say)**

Figs. 46, 76, 106, 136, 161, 186, 188, 198, 236, 237, 260, 263, 334, 335, 336.

Sialis bilineata Say (1823) p. 165. Original description.

Isoperla bilineata Claassen (1931) p. 73. Nymphal description.

This species was first recorded from near Rock Island by Walsh (1862). There is a typical female specimen of *bilineata* without locality label in the SURVEY collection which was named by Walsh as "*Perla bilineata* Say," which strengthens the conclusion that Walsh's record was correct. Although there are no additional records in literature for *bilineata* from Illinois it is our most common species of *Isoperla*. We have numerous records of it from every part of the state, and it is particularly abundant in localities adjacent to the largest rivers.

Adults begin emerging in southern Illinois by the end of March, but their maximum abundance in most of the state is not reached until about the middle of May. Very few specimens are encountered after the end of June. *Bilineata* is therefore a true member of the spring fauna. It is essentially nocturnal and adults are often found in numbers at lights. During the day they may be beaten with a net from vegetation bordering rivers or captured while resting in protected places. The adults emerge from nymphs chiefly at night.

The nymphs make their most rapid growth from January to April. Their size groups as well as seasonal adjustments indicate a life cycle of one year. I have been unable to find the remains of insects in the digestive tract of the many nymphs examined and I believe these nymphs are essentially herbivores. Very large and medium sized rivers are apparently ideally suited to the nymphs, but they are uncommon or absent in many small streams which support such species as *decepta*, *minuta* and *mohri*.



Fig. 336.—HEAD OF *Isoperla bilineata*, NYMPHAL MALE, EXTREME LIGHT FORM.

As mentioned beforehand *Glioperla* and *Isoperla* in restricted senses have been separated in the adults upon the basis of the absence or presence of intercubital crossveins. This character is very unstable and of very little key value. In *bilineata*, the type of the genus *Isoperla*, about one-third of the specimens examined possessed intercubital crossveins, sometimes in both wings and sometimes in but one wing.

Bilineata has a very close ally in the new species which I am naming *richardsoni* in this paper. In the females these two species are easily separated upon the basis of the shape of the subgenital plates, figs. 235, 236, 237, but in the males I have been unable to locate good differential characters. The characters of the apical abdominal segments of the male, so useful in making determinations in many other genera of closely related species, are in general less well developed in *Isoperla* than in most other groups.

The nymphs, fig. 335, described by Claassen (1931), are easily recognized because of their distinctive color pattern. The characters presented by the mouthparts are given in figs. 46, 76, 106, 136. The color pattern, particularly on the head, is subject to some variation in the proportions of light to dark areas and fig. 336 shows the head of an extremely light form. The most important structural features of the adults are shown in figs. 198, 236, 237.

Adults.—Algonquin: July 4, 1907, 1♀; June 28, 1909, 3♂. Alton: May 18, 1932, 1♂, 1♀. Alto Pass: Apr. 17, 1927, 4♂, 1♀. Assumption: Apr. 16, 1927, 1♀. Brookport: Mar. 28, 1932, 1♂. Byron: May 19, 1927, 1♀. Champaign: June 9, 1888, 1♂. Chester: May 11–16, 1932, ♂♂, ♀♀. Dixon: May 31, 1914, 1♂. Dixon—Oregon: June 27, 1927, 1♂. E. Du-buque: July 21, 1927, 1♀; June 26, 1928, 2♂; June 15–24, 1932, 2♂, 1♀; June 1, 1933, ♂♂, ♀♀. Elizabethtown: June 22, 1927, 12♂, 5♀; May 30, 1928, 4♂, 3♀. Florence: June 7, 1928, 1♀. Fountain Bluff: May 15, 1932, 1♂, 1♀. Golconda: May 13, 1932, 1♂, 1♀. Grafton: May 10, 20, 1932, ♂♂, ♀♀. Grand Detour: May 15, 1930, 2♀. Grand Tower: Apr. 21, 1914, 1♂; May 12–15, 1932, ♂♂, ♀♀. Hamilton: June 22, 1928, 2♂; June 3, 1930, 2♂. Hardin: June 25, 1931, 1♀. Havana: May 3, 4, 6, 1894, 3♂; May 6,

1895, 1♂; Apr. 1896, 1♀; June 9, 1905, 5♂, 9♀; May 23, 1911, 1♀; Apr. 30, 1914, 2♀; June 22, 1928, 1♂, 1♀; May 21, 1932, 1♂, 3♀; May 31, 1933, ♂♂, ♀♀; May 9, 1934, 1♂. Henry: June 3, 1933, 1♀. Kampsville: June 25, 1931, 1♂, 3♀. Keithsburg: June 9, 1932, ♂♂, ♀♀. Loda: Apr. 24, 1929, 1♂. Mattoon: May 16, 1933, 1♀. Meredosia: May 29, 1917, 1♀; May 31, 1928, ♂♂, 5♀; May 20, 1932, 1♂. Merrimac: May 11, 1932, ♂♂, ♀♀. Metropolis: Mar. 28, 1932, 1♂, 1♀. Momence: June 4, 1932, ♂♂, ♀♀. Mt. Carmel: Apr. 14, 1930, 4♂, 1♀; Apr. 19, 1932, 1♂, 1♀. New Boston: June 14, 1931, 3♀. Oakwood: May 8, 1927, 1♀. Oregon: July 18, 19, 1927, 4♀; June 27, 28, 1928, 1♂, 2♀. Prairie du Rocher: May 17, 1932, 1♂, 1♀. Rockford: May 12, 1927, ♂♂, ♀♀; June 13, 1931, 2♂. Rock Island: June 23, 1928, 2♂; June 3, 1930, ♂♂, 4♀; May 16, 1931, 15♂, 37♀; June 13, 24, 1931, 1♂, 3♀; May 9, 10, 1932, ♂♂, ♀♀; May 11, 1934, 1♂. Shawneetown: June 21, 1927, 2♀; May 26–28, 1928, 8♂, 1♀. Sparland: June 3, 1933, ♂♂, ♀♀. Sterling: May 4, 5, 21, 22, 1925, 6♂, 10♀. Urbana: May 19, 20, 1887, 4♂; May 25, 1892, 1♂, 1♀; May 1927, 1♀; Apr. 30, 1929, 1♀; May 17, 1931, 1♂; May 11, 1933, 1♀; June 8, 1933, 2♀. Warsaw: June 10, 1932, ♂♂, ♀♀. White Heath: Apr. 30, 1927, 1♀. Zeigler: Apr. 20, 1929, 1♀.

Nymphs.—Alton (Mississippi r.): May 1932, exuviae. Brookport (Ohio r.): Mar. 28, 1932. Byron (Rock r.): May 19, 1927. Charleston (Embarrass r.): Mar. 28, 1932. Chester (Mississippi r.): May 11, 1932. Dixon (Rock r.): May 12, 22, 1925; Apr. 3, 1928. Fountain Bluff (Mississippi r.): May 15, 1932, exuviae. Golconda (Ohio r.): May 13, 1932. Grafton (Mississippi r.): May 20, 1932. Grand Tower (Mississippi r.): May 12–15, 1932. Joppa (Ohio r.): Mar. 28, 1932. Kankakee (Kankakee r.): Apr. 30, 1931. Keithsburg (Mississippi r.): Apr. 4, 1932. Merrimac (Mississippi r.): May 11, 1932, exuviae. Mt. Carmel (Wabash r.): Apr. 2, 19, 1932. Oregon (Rock r.): Apr. 3, 1928; May 15, 1930; Apr. 19, 1931. Prairie du Rocher (Mississippi r.): May 17, 1932, exuviae. Rockford (Rock r.): Apr. 29, May 4, 1926; Apr. 26, May 12, 1927; Apr. 3, 1928. Rock Island (Mississippi r.): Apr. 2, 1928; Apr. 10, 18, May 16, 1931; Mar. 2, Apr. 3, 27, May 9, 1932; Apr. 26, 1933. Shelbyville (Kaskaskia r.): Apr. 9, 1932. Sterling (Rock r.): May 4, 5, 13, 19, 1925; Apr. 3, 1928; Apr. 27, 1932.

Reared from nymphs.—Rock Island: Apr. 3, May 3, 1931.

Isoperla clio (Newman)

Figs. 47, 77, 107, 137, 145, 337.

Isogenus clio Newman (1839) p. 86. Original description.

Clioperla clio Claassen (1931) p. 69. Nymphal description.

We have obtained very little information concerning this species. It was first recorded from Illinois by Claassen (1931) on the basis of nymphs and reared specimens from Work's brook, Ottawa, April 3, 1902. During the course of our field work we have collected only two nymphs, one nymphal cast skin and no adults.

Our identification as *clio* is based upon the similarity of the nymph with the drawing given by Claassen (1931). Descriptions and drawings

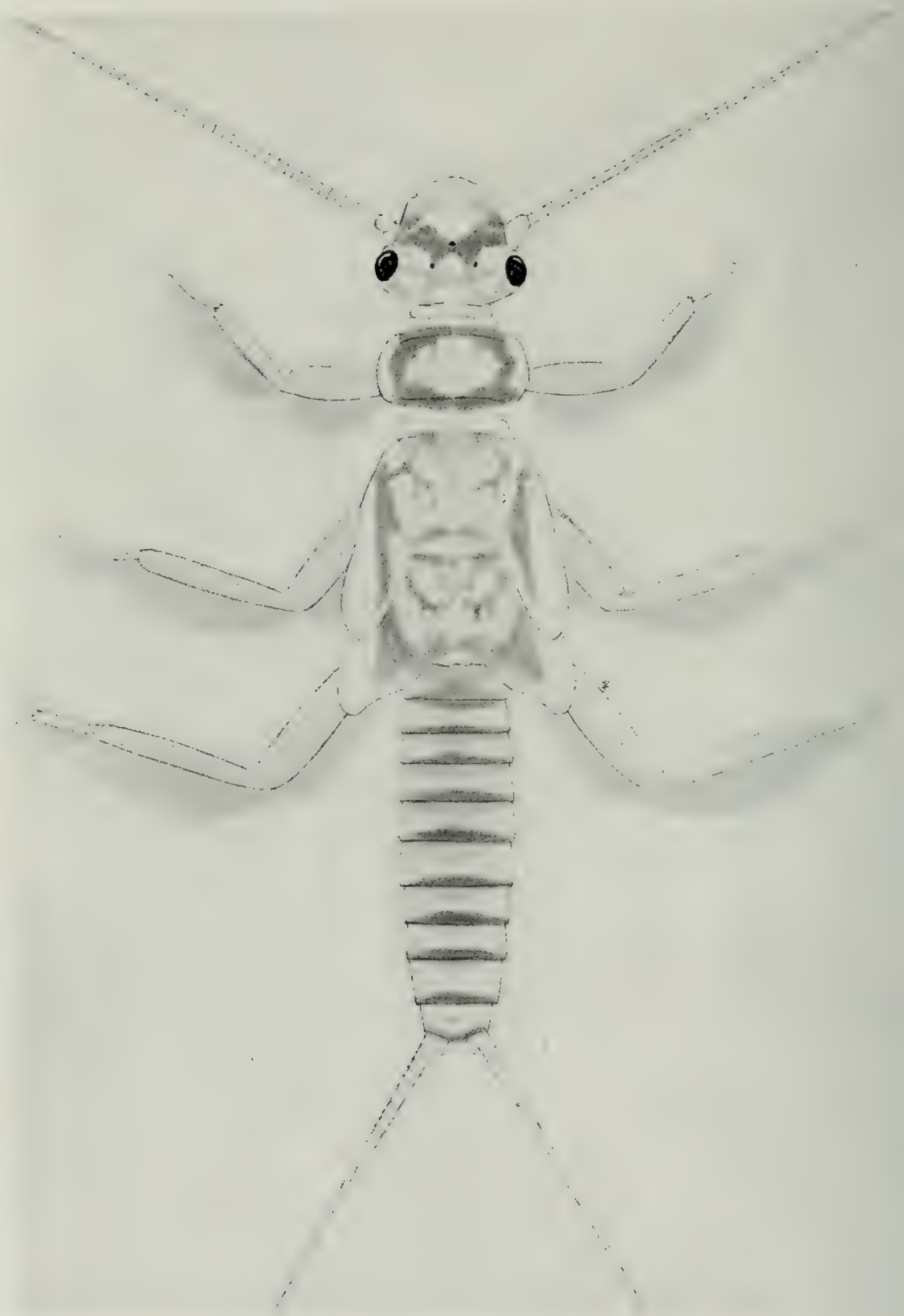


Fig. 337.—*Isoperla clio*, NYMPHAL FEMALE.

of the adults of *clio* as presented by Needham and Claassen (1925) indicate that this species is structurally very close to what I am calling *Iso-*

perla confusa. There is a possibility that the true *clio* Newman is the species I am naming *confusa* and that the species under discussion here is without a name. It may be, too, that the nymph figured by Claassen (1931) has been wrongly associated with its adult but his statement concerning "reared specimens" seems to prohibit such a supposition. My repeated efforts to secure adults of the nymph here called *clio*, for comparison with *confusa*, have failed. If previous associations of nymphs and adults under the name *clio* are in error, even the species *conspicua* must be considered because its nymph is not definitely known and it comes from the same area as our nymphs at present named as *clio*. Accepting the adult and nymph of *clio* as correctly associated, we have in *confusa* a species with a very differently colored nymph but an adult of many similarities.

The cast nymphal skin collected in the early part of April, as well as Claassen's record from Ottawa, proves that this species is a member of the early spring fauna. The structure of the mouthparts indicates that the nymph is essentially carnivorous.

Nymphs.—Rockford (Rock r.): Apr. 3, 1928, 1♂. Rock Island (Rock r., Mississippi r.): Apr. 2, 1928, 1♀; Apr. 27, 1932, exuvia.

***Isoperla confusa*—NEW SPECIES**

Figs. 1, 48, 78, 108, 138, 165, 205, 251, 338.

Our records for this new species indicate that it is particularly common in the Wabash watershed, on the Indiana side as well, but apt to be found anywhere in Illinois. If this picture of its distribution in the state means anything concerning its range in general, we may infer that the center of its distribution lies to the south and east of Illinois.

Our field observations and rearings of adults prove that *confusa* is a member of the early spring fauna. In our rearing cages at Charleston the first adults were found on March 28 and adults continued to emerge until April 11. The adults are diurnal and have habits in general suggestive of *Hydroperla*. Very few adult specimens are secured without rearing from nymphs because they are never abundant in comparison with such species as *bilineata*, and at times *minuta* and *decepta*.

The nymphs, like those of *Hydroperla crosbyi*, are most often found in clumps of decaying leaves, fig. 14, which are lodged in the water against stones, branches or logs. They seem to be partial to small or medium sized streams with sandy or rocky bottoms. Remains of insects in the digestive tract testify to their carnivorous habits. The size classes of nymphs indicate that one year is required for the completion of the life cycle.

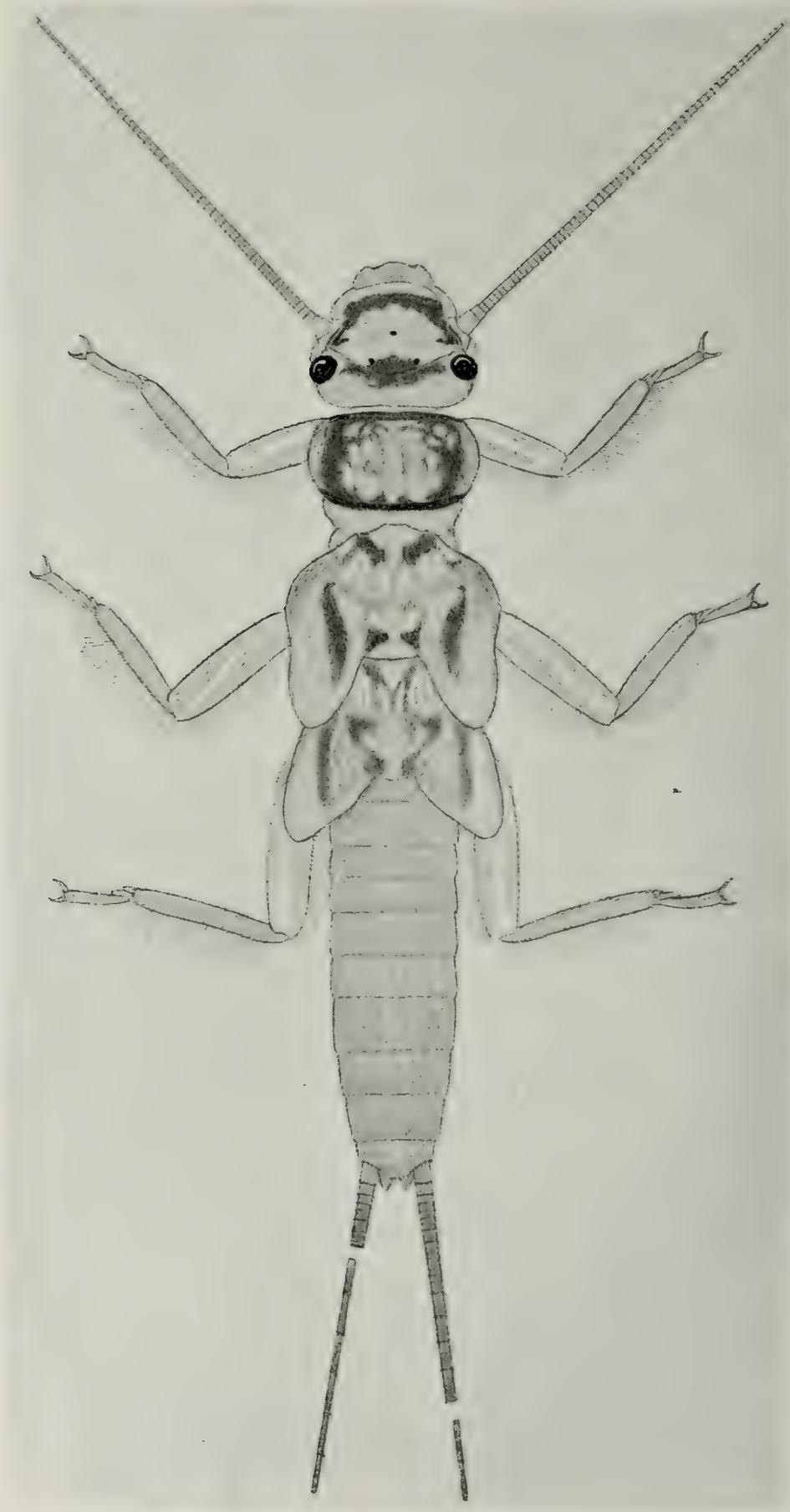


Fig. 338.—*Isoperla confusa*, NYMPHAL MALE.

The comment under *I. clio* concerning the present possible misuse of specific names, p. 441, should be noted.

Male.—Length to apex of wings 16 mm.; length to apex of abdomen 14 mm. General color in life black contrasting with orange-yellow. Orange-yellow dorsal areas are as follows: a spot anterior to median ocellus; area around compound eyes; spot on posterior margin of head running forward into ocellar space; longitudinal median stripe on pronotum; most of meso- and meta-notum; and all abdominal tergites. Venter mostly orange-yellow with dark brown or black lateral spots on thoracic segments and along lateral margins of abdomen. Antennae, cerci and legs except for extreme yellowish apical part of femora are chiefly black or dark brown.

Head much wider through compound eyes than width of pronotum; three ocelli nearly forming an equilateral triangle, lateral ocelli placed about on a line with middle of compound eyes, about as far removed from one another as from compound eyes. Antennae with about 50 segments; basal segments wider than long, middle and apical segments longer than wide.

Pronotum approximately quadrangular, much broader than long, angles rather sharp; pronotal flange well developed on anterior margin but weakly developed on sides and on posterior margin; a rather distinct pattern of raised rugosities on surface; and with a longitudinal median depressed stripe about as wide as distance between lateral ocelli.

Legs with first and second tarsal segments very short, first slightly longer than second, third long.

Wings long, extending beyond tip of abdomen, up to 14 mm. in length; membrane dull hyaline, veins very dark and contrasting; venation essentially as in type of genus.

Abdomen with dorsal segments without special apical structures, fig. 205. Ninth tergite with two patches of small sharp spinules on posterior portion. Tenth tergite not cleft, fig. 205. Eighth sternite with a small lobe in middle of posterior margin. Ninth sternite strongly produced and turned upward around tenth segment so that it is not visible from below, and without a distinct disklike pad near middle of apical portion. Cerci long, many segmented. No gill remnants on any body area.

Female.—Length to apex of wings 20 mm.; length to apex of abdomen 15 mm. Head, thorax, abdomen and appendages in general similar to those of male. Differs from male as follows: eighth abdominal sternite with posterior margin or subgenital plate rounded and slightly extended posteriorly, fig. 251.

Holotype, male.—Oliver, Ill. (Big cr.): Apr. 7, 1932, reared from nymph collected by T. H. Frison and H. H. Ross.

Allotype, female.—Same data as for holotype.

Paratypes.—Marshall: Apr. 1, 1932, 1 ♂; Apr. 9, 1933, 1 ♂. Oakwood: Apr. 12, 1933, 1 ♂. Oliver: Mar. 28, Apr. 1, 4, 7, 11, 1932, 21 ♂, 18 ♀, reared

from nymphs taken in Big creek. Turkey Run state park, Ind. (Sugar cr.): Apr. 19, 1933, 1♂; May 7, 1933, 1♀ resting on tree; (Newby gulch): May 11, 1933, 1♀ reared. Montezuma, Ind.: Apr. 13, 1933, 1♂. Collected by T. H. Frison, H. H. Ross, C. O. Mohr.

Nymphal male, fig. 338.—General color of head, thorax and legs a whitish yellow; general color of dorsum of abdomen brown and venter paler. Dorsum with dark markings as follows: a band anterior to articulation of antennae and continuing part way along side of head; a transverse stripe connecting compound eyes and lateral ocelli; narrow band on anterior and posterior margins of pronotum and a wider band on lateral margins except that extreme lateral edge is pale; various suffused areas on thorax as in fig. 338. Some paired whitish spots on abdominal tergites.

Head with three ocelli nearly forming an equilateral triangle, lateral and median ocelli occupying the same relative position as in adult. Antennae yellowish at base and gradually becoming darker towards apex, with more than 50 segments. No occipital ridge. No pronounced row of stout setae associated with posterior margin of compound eye. Labrum, fig. 48, labium, fig. 138, maxilla, fig. 108, mandibles, fig. 78, and submentum, fig. 165, as shown.

Pronotum about twice as wide as long, all angles well rounded; marginal groove present on anterior and posterior margins but absent on lateral margins. Mesonotum with wing pads extending almost straight backwards, those on metanotum extending slightly outward as well.

Legs very little flattened; hind margins of femora, tibiae and tarsi with a fringe of long fine setae; femora on outer surface with a longitudinal strip in center which is bare of short setae.

Abdomen with color pattern as in fig. 338. Cerci long, with segments progressively longer apically. Tenth tergite produced backwards and rounded on posterior margin. Eighth sternite with posterior margin almost straight and setal fringe not interrupted in the middle.

Submental, thoracic and abdominal gills entirely lacking.

Mature specimens with a body length, exclusive of appendages, of about 16 mm.

Nymphal female.—In color and most structural details similar to nymphal male. Eighth abdominal sternite has the setal fringe on posterior margin interrupted in the middle.

Nymphs.—Dixon Springs: Feb. 2, 1934. Golconda (Big Grand Pierre r.): Mar. 7, 1928. Harrisburg (Blackman cr.): Mar. 6, Nov. 29, 1928; Apr. 2, 1932. Herod (Gibbons cr.): May 6, 1928; Apr. 20, 1932; Feb. 2, 1934. Marshall (Big cr.): Apr. 9, 1931; Feb. 27, 1932. Oakwood (Salt Fork r.): Nov. 7, 1929; Apr. 12, 1933. Oliver (Big cr.): Jan. 14, Mar. 16, Apr. 11, 1932. Peru (Nigger cr.): Apr. 25, 1933. W. Union (Mill cr.): Feb. 27, 1932. Montezuma, Ind. (Leatherwood cr.): Apr. 13, 1933. The Shades, Ind.: Nov. 12, 1927. Turkey Run state park, Ind. (Newby gulch): Apr. 13, 1933; (Sugar cr.): Apr. 19, 1933. Veedersburg (Coal cr.): Mar. 18, 1933.

Reared from nymphs.—Oliver (Big cr.): Mar. 28, Apr. 1, 4, 7, 11, 1932. Collected by T. H. Frison, H. H. Ross, C. O. Mohr.

Isoperla conspicua—NEW SPECIES

Fig. 239.

This new species is described upon the basis of a single female discovered in one of our rearing cages at Rock Island, Ill. This particular cage was known to us to contain nymphs of *I. bilineata* and *Hydroperla harti*, adults of which were reared, but we were not aware of the existence of a third species. No cast nymphal skin was discovered which could be associated with this new species. Therefore the nymph is unknown. There is a slight possibility, in case there is a wrong association of adults and nymphs under the name *clio*, that *conspicua* may be the adult of the nymph now recorded from Illinois as *clio*, which see.

The date of rearing of *conspicua* indicates that it is a member of the spring fauna. Our collecting in the state has been sufficiently thorough to show that it is one of our rarer species. The shape of the subgenital plate, fig. 239, is very suggestive of the figure given for *I. sobria* (Hagen), known only from Colorado, by Needham and Claassen (1925). It differs from the description of *sobria* of these authors in several points and until the isoperlid species are better known I believe that it would be a mistake to consider them as the same.

Female.—Length to apex of wings, 12 mm.; length to apex of abdomen, 9 mm. General body color brown with yellowish brown markings. Head and thorax with yellowish markings as follows; an irregular area adjacent to sides of head and extending back to posterior margin of head; a large spot in ocellar space; a small part anterior to median ocellus; a longitudinal median stripe on pronotum slightly narrower than distance between lateral ocelli; outer lateral portions of pronotum; and median spots on meso- and metanotum. Abdomen much lighter than thorax, posterior margins of tergites slightly darker than anterior portions, traces on first five tergites of longitudinal alternating light and dark stripes and some small paired spots. Antennae and legs essentially brown, cerci with basal portions of segments yellowish and apical portions more brown and contrasting. Venter of head and thorax yellowish brown with large lateral dark areas on thorax; abdomen essentially pale brown, lighter surrounding subgenital plate. Wings hyaline with veins dark brown and contrasting. No gill remnants on any body area.

Head slightly wider than prothorax; three ocelli forming a triangle, lateral ocelli slightly more removed from one another than from median ocellus; lateral ocelli situated about on a line with middle of compound eyes. Antennae many segmented, from base to apex the segments becoming progressively longer.

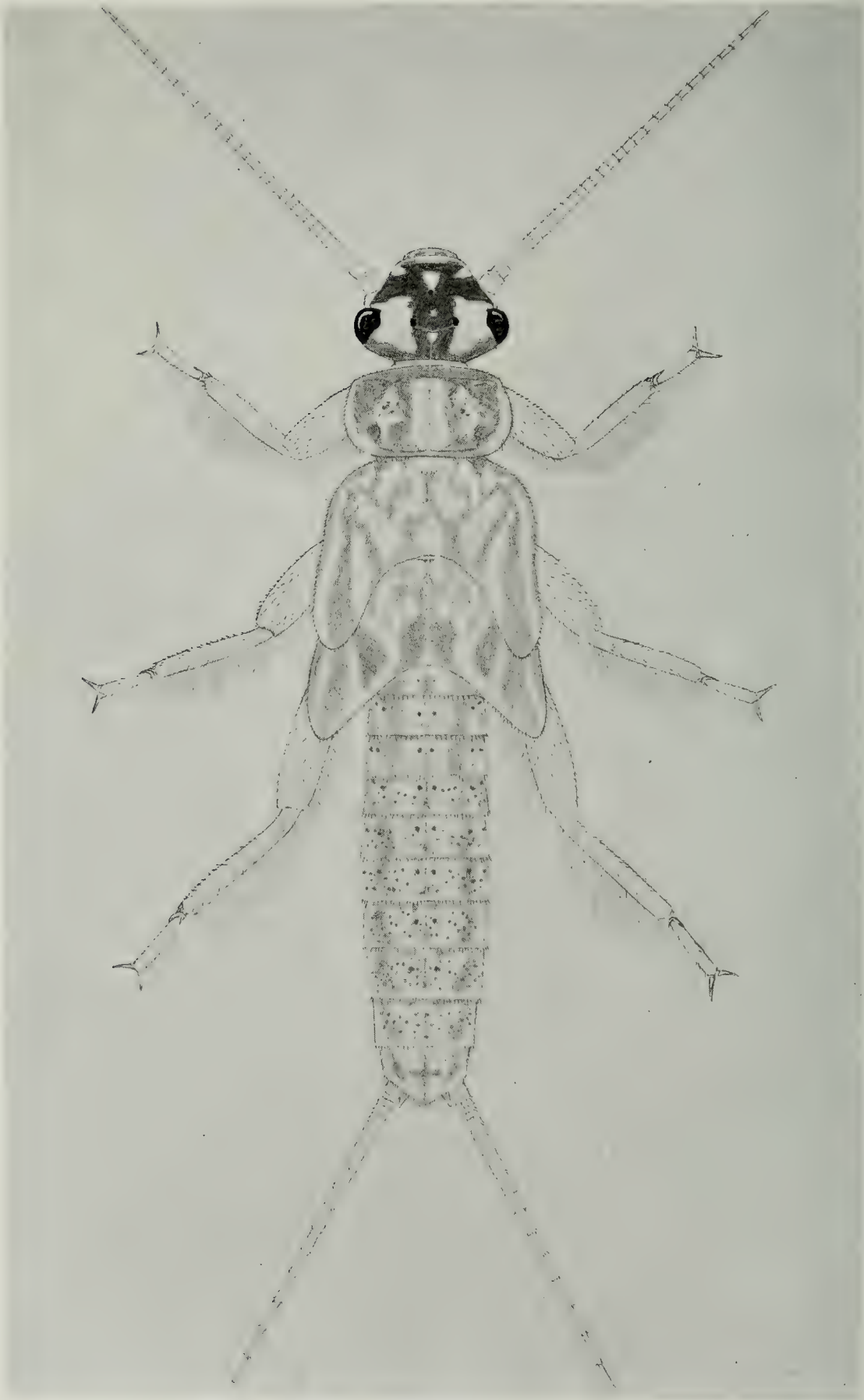


Fig. 339.—*Isoperla decepta*, NYMPHAL FEMALE.

Pronotum approximately quadrangular, much broader than long, angles sharp; anterior margin rounded; pronotal groove well developed on anterior margin but elsewhere indistinct; a distinct pattern of raised brownish rugosities between depressed median area and lateral margins; longitudinal median area slightly narrower than distance between lateral ocelli.

Tarsal segments as in other isoperlids.

Wings extending beyond abdomen and with venation essentially as in type of genus.

Abdomen without special structures on tergites. Eighth sternite with a well developed subgenital plate, deeply notched in middle of posterior margin and slightly overlapping base of ninth sternite, fig. 239. Cerci long and many segmented.

Holotype, female.—Rock Island, Ill. (Rock r.): May 16, 1931, reared from nymph collected by T. H. Frison, H. H. Ross and C. O. Mohr.

***Isoperla decepta*—NEW SPECIES**

Figs. 49, 79, 109, 139, 163, 192, 233, 332, 339.

Superficially this species in the adult greatly resembles *I. bilineata*. Its existence was first brought to our attention because of the distinctive nymphs, fig. 339. The adults belong to that group of small isoperlids which are dominantly whitish or lemon yellow with contrasting black ocelli and compound eyes and some subdued brownish markings. In Illinois this group comprises the species *bilineata*, *richardsoni* and *decepta*.

Our records are all from extreme southern Illinois and it may be considered as a species associated with the Ozarkian uplift region in our state. It is a true member of the spring fauna.

The adults are diurnal and emerge from nymphs during the day. Dr. Ross has observed them emerging from nymphs and noted that they were able to fly almost immediately after leaving the nymphal skins. During the day the adults congregate upon the vegetation near the streams inhabited by the nymphs and at times fly off over the surrounding fields. These diurnal habits are in marked contrast to *bilineata* which is nocturnal and attracted by lights.

The nymphs are found in small rapid streams which have a sand and gravel bottom. One of the nymphs when collected had a half eaten chironomid larva in its mouth. This indicates a carnivorous habit but the digestive tracts of other nymphs when examined have not contained insect remains and the nymph may be mostly herbivorous.

Male.—Length to apex of wings 10 mm.; length to apex of abdomen 7 mm. In life the species is essentially lemon yellow with some dark or brownish areas and strongly contrasting black ocelli and compound eyes. The dark or brownish areas are as

follows: apical antennal segments; two longitudinal stripes on pronotum separated by wide light median stripe and bordered by narrow yellow lateral margin; a few fuscous areas on meso- and metanotum and along prominent sutures; and faint suggestions of fuscous spots on basal abdominal tergites. The cerci are slightly fuscous apically but not as dark as antennae. Legs essentially yellowish but with tarsi somewhat fuscous and with a narrow fuscous ring about the length of longest tarsal segment, at base of tibia. Venter uniformly whitish yellow. Median and lateral ocelli not connected by a dark line. No gill remnants on any body region.

Head much wider than pronotum; ocelli nearly forming an equilateral triangle; lateral ocelli closer to compound eyes than to each other and situated about on a line with middle of compound eyes. Antennae long, many segmented, segments progressively longer from base to apex.

Pronotum quadrangular, much broader than long; marginal groove indistinct except on anterior margin; angles not noticeably rounded.

Legs with first and second tarsal segments very short, second shorter than first and third much longer than either.

Wings with veins arranged essentially as in *I. bilineata* (Say); intercubital crossveins lacking. Veins colored in fresh material as follows: medius and second to fifth branches of radius of forewing brown and contrasting with the remainder of light veins of fore- and hind wings.

Abdomen with dorsal segments without special structures and tenth tergite not cleft. Ninth sternite prolonged backwards and upwards, concealing tenth sternite. Eighth sternite with a very small knob in middle of posterior margin, fig. 332.

Female.—Slightly larger than male and like it in general color and most morphological details. Differs in having eighth abdominal sternite with slightly protruding and rounded subgenital plate, fig. 233.

Holotype, male.—New Columbia, Ill. (Clifty cr.): Apr. 22, 1932, collected by H. H. Ross and C. O. Mohr.

Allotype, female.—Same data as for holotype.

Paratypes.—Same data as for holotype, 85♂, 86♀. Same data as for holotype but specimens reared, 3♂, 14♀. Herod (Gibbons cr.): Apr. 20, 1932, 4♂, 3♀; (Blackman cr.): Apr. 20, 1932, 21♂, 16♀, reared. McClure: May 5, 1932, 4♂, 2♀. Ozark: May 18, 1932, 2♂. Vienna: Apr. 21, 1932, 5♂, 5♀. Collected by T. H. Frison, H. H. Ross, C. O. Mohr, H. L. Dozier.

Nymphal male, fig. 339.—General color pattern with brownish and whitish yellow areas as in the illustration. Numerous freckle-like spots scattered over abdominal tergites in addition to some larger paired spots. Venter with head and thorax light yellowish, abdominal sternites more brownish and with numerous freckle-like spots. Legs, antennae and cerci whitish yellow.

Head with three ocelli nearly forming an equilateral triangle; lateral ocelli about as far removed from one another as from compound eyes and situated about on a line with middle of compound eyes. No occipital ridge. No conspicuous row of stout setae bordering posterior margin of compound eye. Labrum, fig. 49, labium, fig. 139, maxilla, fig. 109, mandibles, fig. 79, and submentum, fig. 163, as illustrated.

Pronotum much broader than long; angles rounded, particularly posterior angles. Marginal groove absent on side margins but present on anterior and posterior margins. Wing pads on mesonotum extending almost straight backwards, those on metanotum extending slightly outward.

Legs but slightly flattened; with a posterior fringe of long fine setae; femora with numerous short setae.

Abdomen marked as in fig. 339. Cerci long, many segmented, segments progressively longer apically. Tenth tergite produced backwards on posterior margin. Eighth sternite with posterior margin straight and transverse setal fringe not interrupted in middle.

Submental, thoracic and abdominal gills absent.

Nymphal female.—Similar to male in general color and most morphological details. Eighth abdominal sternite with transverse row of setae on posterior margin interrupted in the middle.

Nymphs.—Herod (Blackman cr., Gibbons cr.): Apr. 2, 20, 1932, nymphs and exuviae. New Columbia (Clifty cr.): Apr. 3, 20, 22, 1932, nymphs and exuviae. Vienna (creek east of town): Apr. 21, 1932, nymphs and exuviae. Rocky Branch: Mar. 27, 1932. Collected by T. H. Frison, H. H. Ross, C. O. Mohr, B. Harper.

***Isoperla duplicata* (Banks)**

Figs. 50, 80, 110, 140, 204, 249, 340, 341.

Perla duplicata Banks (1920) p. 316. Original description.

Although we have not actually taken this species in Illinois, we have taken it in the Wabash watershed of Indiana and so close to our state borders that its inclusion seems desirable. It is certainly aberrant in many respects for a typical *Isoperla*, but as stated elsewhere I am using *Isoperla* in a broad sense until more information is available.

Needham and Claassen (1925) have placed *duplicata* in the genus *Perla* and in their new subgenus *Diploperla*. According to the classification proposed in this paper, *duplicata* belongs in the family Chloroperlidae and to one of the natural aggregates or groups of species under *Isoperla* (*s. lat.*). The two species placed in the subgenus *Diploperla*,—*duplicata* and *bilobata*—have in the adult males knoblike lobes on the median posterior margin of both the seventh and eighth abdominal sternites, fig. 341. In typical *Isoperla*, such as *bilineata*, there is but one such lobe on the

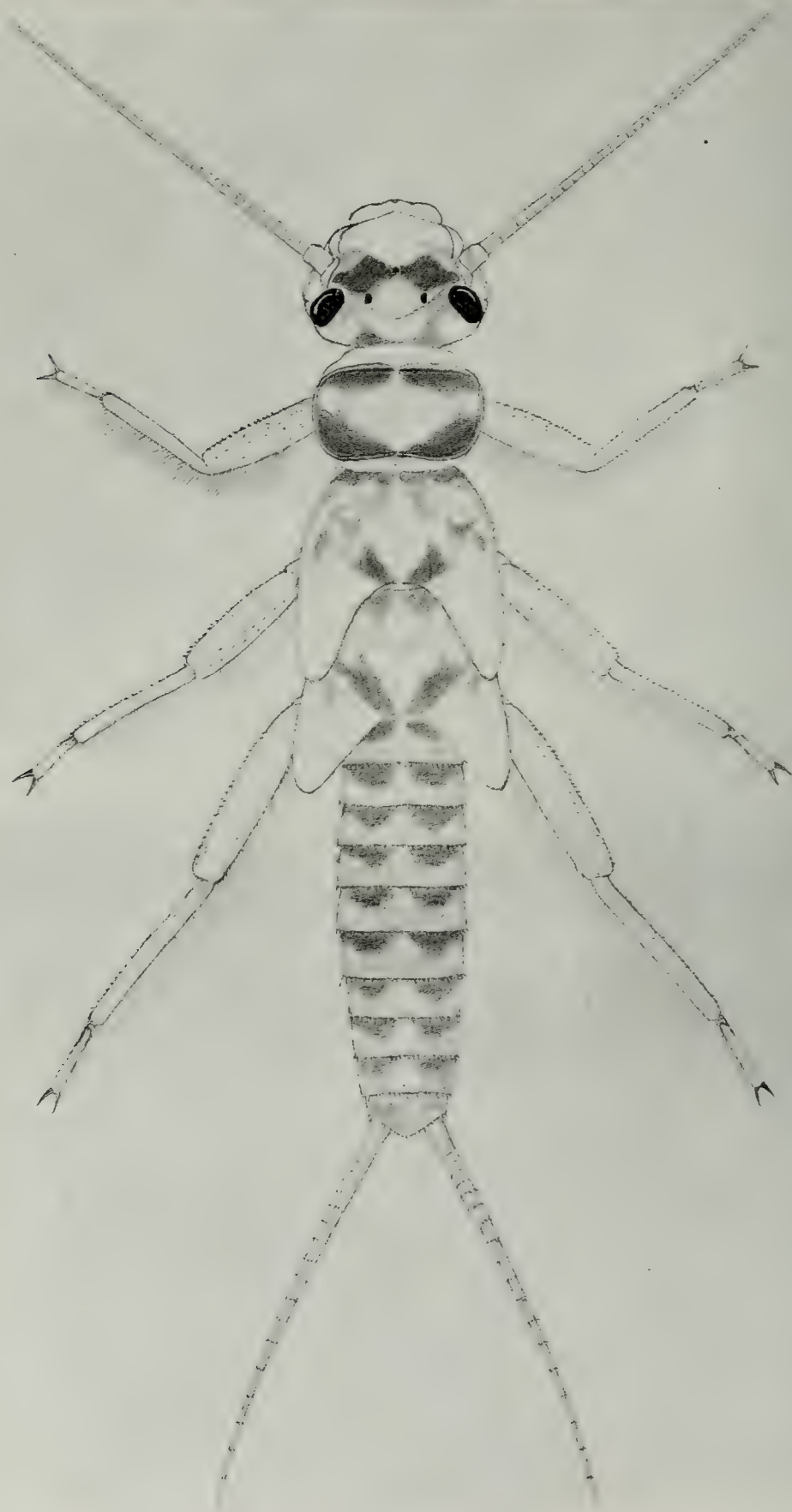


Fig. 340.—*Isoperla duplicata*, NYMPHAL FEMALE.

eighth sternite. A vastly more important difference is the cleft of the tenth abdominal tergite and type of genital structures of the male, fig. 20†, which are quite unlike typical *Isoperla* or certain species which might be considered as belonging to the subgenus *Glioperla*. The lack of a workable character for separating the nymphs of *duplicata* from those of other *Isoperla* is my only reason for not recognizing at this time *Diploperla* as a valid genus. The lacinia, fig. 110, which is different, does not help because the lacinia of most all isoperlids apparently differs.

Our rearings of adults (May 11, 12) at our Charleston station from nymphs collected in Turkey Run state park (Newby gulch), Indiana, indicate that this species is a true member of the spring fauna. It is apparently diurnal in habit. Previously the adults have been recorded only from New Jersey, North Carolina and Virginia. Our Indiana records therefore extend its known distribution considerably.

The nymphs were taken in masses of leaves lodged against stones or other objects in a very small stream. Like other large isoperlids, for example *I. confusa*, this species is not abundant and is outnumbered 10 to 1 by a smaller stonefly, *Chloroperla cydippe*, present in the same stream and reaching maturity about the same time. The life cycle apparently requires one year. The nymph is carnivorous as indicated by the numerous insect remains found in the digestive tract of the one specimen dissected.

The adults have been described by other writers. Distinctive features for identification purposes are given in the keys to adults and nymphs, and in the figures enumerated there.

Description of the heretofore undiscovered nymph follows.

Nymphal male, fig. 340.—General ground color pale yellow or whitish yellow with dark brown or black markings as in the illustration. Most prominent of the dark markings are the transverse band on head anterior to compound eyes and constricted in middle near median ocellus, and the dark areas on the pronotum. Ventral aspect almost uniformly yellow.

Head wider than pronotum, with three ocelli forming a triangle; lateral ocelli slightly more removed from one another than from median ocellus. No occipital ridge. No prominent row of short stout setae surrounding posterior portion of compound eye. Labrum, fig. 50, labium, fig. 140, maxilla, fig. 110, and mandibles, fig. 80, as illustrated.

Pronotum broader than long, but not as broad as head; angles all rounded. Marginal groove distinct on anterior and posterior

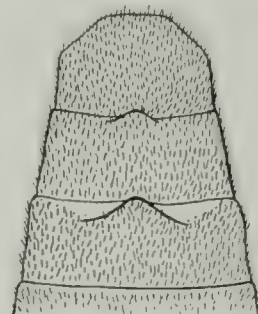


Fig. 341.—VENTRAL VIEW OF TERMINAL ABDOMINAL STERNITES OF *Isoperla duplicata*, ADULT MALE.

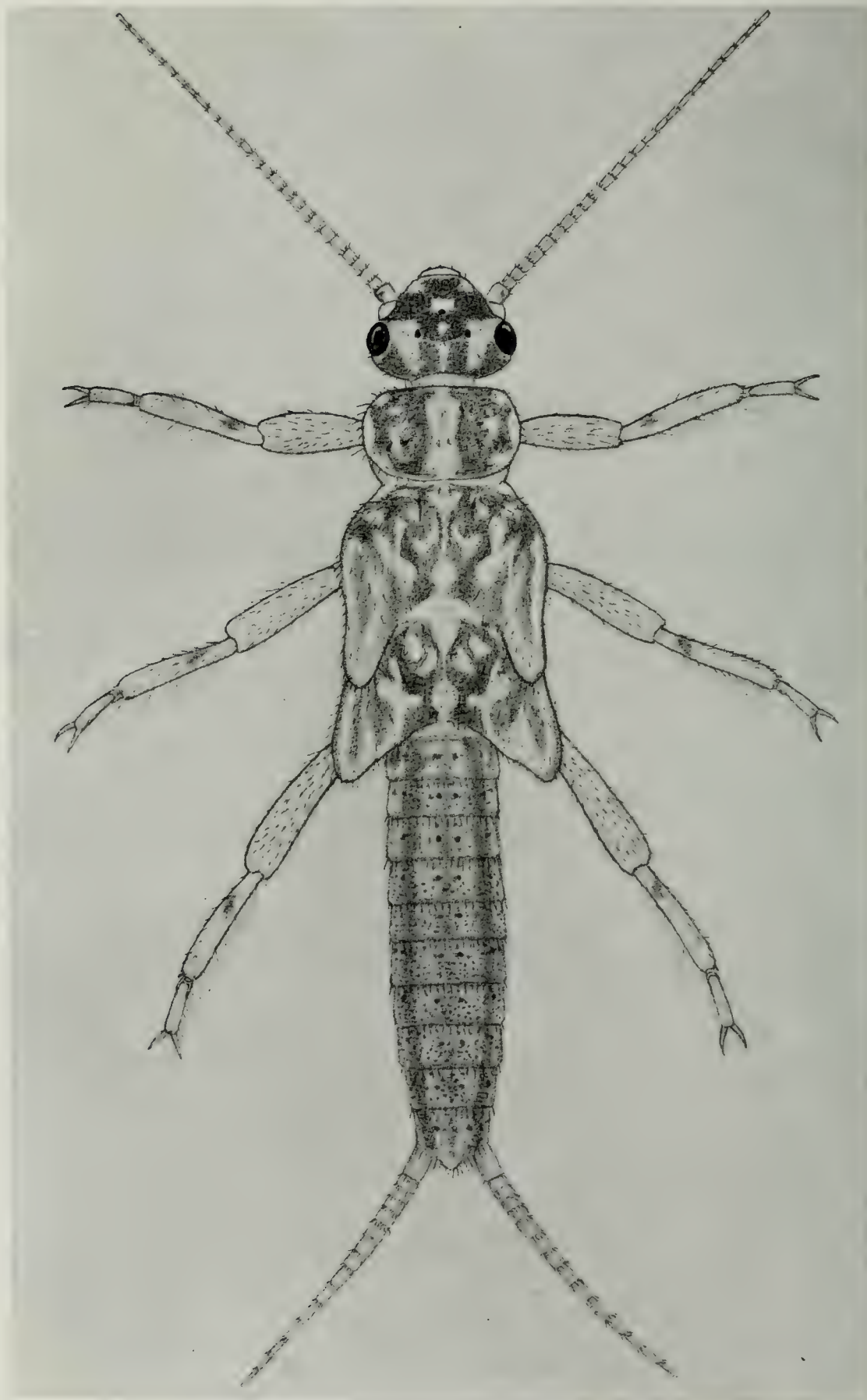


Fig. 342.—*Isoperla minuta*, NYMPHAL FEMALE.

margins but weak on lateral margins. Mesonotal wing pads extending chiefly backwards, metanotal wing pads extending slightly outward as well.

Legs essentially as described for other isoperlids.

Abdomen with markings as in fig. 340. Cerci about as long as abdomen, many segmented, segments progressively longer apically. Setae on posterior margin of eighth sternite interrupted in middle.

Submental, thoracic and abdominal gills all absent. Mature specimens with a body length, exclusive of appendages, of 19 mm.

Nymphal female.—Like male, even to setae on posterior margin of eighth sternite interrupted in middle. Sexes therefore difficult to separate until specimens are mature enough to show indications of sexual structures.

Adults.—Reared from nymphs from locality as given below, 4♂, 1♀.

Nymphs.—All from small stream in Turkey Run state park, Ind. (Newby gulch): May 6, 1928; May 4, 1929; Apr. 13, May 6, 11, 1933.

Isoperla minuta (Banks)

Figs. 51, 81, 111, 141, 158, 196, 234, 342.

Chloroperla minuta Banks (1900) p. 244. Original description.

The adult of *I. minuta* is the smallest of the Illinois species of *Isoperla*. It is this fact which has suggested to me that the "*Chloroperla nana*" of Walsh (1862) might be this species.

The maximum abundance of the adults is reached in central Illinois about the last of May, a seasonal timing somewhat later than for most Illinois isoperlids. All of our records for *minuta* are from the central and eastern part of the state. This distribution corresponds essentially with that Illinois area which was once upland prairie, and there may be some correlation between the two. The environment and abundance of *minuta* near Seymour is certainly suggestive of this correlation. Needham and Claassen (1925) list this species from Ohio and Illinois, the types coming from the former state.

I. minuta was found to be exceedingly abundant near Seymour, Ill., May 27, 1929. About noon on the clear warm day of this date, thousands of the adults were observed climbing about on the vegetation bordering a very small tributary of Camp creek. Some of these adults were engaged in mating whereas others were feeding upon the pollen of dock (*Rumex*) and wild grape (*Vitis*).

The nymphs were found in the creek clinging to decaying vegetable matter or on the sides of submerged boards or branches of trees. This particular stream is very small, flows through a rich soil area which was

once prairie, and is so full of vegetative growth that it seems almost stagnant. I have failed to find insect remains in the digestive tracts of nymphs, and believe that they are herbivorous.

Genital structures of the adults, which have been described elsewhere, are shown in figs. 196, 234. Following is a description of the previously unrecognized nymphs.

Nymphal female, fig. 342.—Dorsum with a definite color pattern of contrasting brown and yellowish brown areas. Particularly important is that the dark area on forepart of head from median to lateral ocelli is almost quadrate, and with a small light area in its center. Also, the dorsum of the abdomen has two dark longitudinal stripes and a few rows of distinct paired spots upon a somewhat suffused background dotted with numerous small freckle-like spots. Venter of head and thorax whitish yellow, abdomen more brownish.

Ocelli three, nearly forming an equilateral triangle; lateral ocelli slightly more removed from one another than from median ocellus. Antennae yellowish, many segmented. No occipital ridge. No pronounced row of stout setae associated with posterior margin of compound eye. Labrum, fig. 51, labium, fig. 141, maxilla, fig. 111, mandibles, fig. 81, and submentum fig. 158, as shown.

Pronotum more than twice as broad as long; all angles well rounded. Marginal groove weakly developed. Mesonotum with wing pads extending slightly outward, those on metanotum extending more outward.

Legs very little flattened, with short stout setae and more slender hairlike setae mixed; fringe of long fine hairlike setae on posterior margin of legs poorly developed.

Abdomen with color pattern as in fig. 342. Cerci brown, short and stout in comparison with most other isoperlids. Eighth sternite with transverse row of setae on posterior margin interrupted in the middle.

Nymphal male.—Similar in almost all respects to female. Eighth sternite with setae on posterior margin not interrupted in the middle.

Adults.—Allerton: June 17, 1929, 1 ♂, 1 ♀. Charleston: May 30, 1929, 2 ♂. Clinton: May 31, 1933, 1 ♂. Homer: June 5, 1924, 8 ♂, 12 ♀; June 5, 1925, 2 ♂, 3 ♀; June 1, 1931, 1 ♀. Kankakee: June 5, 1932, 1 ♀. Ludlow: June 9, 1929, 1 ♂, 1 ♀. Muncie: May 16, 20, 1909, 12 ♂, 5 ♀; June 10, 1919, 2 ♀; May 12, 21, 1928, 6 ♂, 3 ♀. Oakwood: June 14, 1930, 1 ♂. Rantoul: June 9, 1929, 1 ♀. Seymour: May 25–27, 1929, 43 ♂, 75 ♀; June 13, 1929, 10 ♂, 12 ♀; May 13, 1933, ♂♂, ♀♀. Sheldon: June 4, 1932, ♂♂, ♀♀. Sherman: May 22, 1930, 1 ♂. Springfield: July 4, 1885, 3 ♂. St. Joseph: May 7, 1905, 1 ♂; May 25, 1913, 1 ♂; May 17, 1914, 6 ♂, 6 ♀. Urbana: May 31, 1889, 1 ♀; May 13–15, 1898, 3 ♂, 3 ♀; May 29, 1928, 1 ♂, 1 ♀; May 31, 1929, 1 ♂. White Heath: May 19, 1933, 1 ♂, 1 ♀.

Nymphs.—Dolson (Big cr.): May 12, 1933. Oakwood (trib. of Salt

Fork r.): Apr. 12, 1933. Oliver (trib. of Big cr.): May 11, 1933. Seymour (Camp cr.): May 27, 1929; Apr. 13, 28, 1932. St. Elmo (S. Fork cr.): Apr. 1, 1932.

Mating pair.—Oakwood: June 1, 1930.

Isoperla mohri—NEW SPECIES

Figs. 52, 82, 112, 142, 162, 193, 238, 333, 343.

One of the surprises of our stonefly investigations was the discovery in a small stream near Watson of an isoperlid nymph with a head pattern suggestive of *minuta* and *decepta* and the abdomen more like *bilineata*. Rearing of the nymph produced a beautiful black and orange-yellow adult. We were expecting to rear an adult dominantly whitish or lemon yellow, such as the typical *bilineata* or our new species *decepta*. Since this species is undescribed I am dedicating it to Dr. C. O. Mohr, associate entomologist of the SURVEY, who has accompanied the author on so many stonefly expeditions in the state, assisted with the rearing of adults from nymphs, and made the many drawings used in this report.

We know very little about the distribution of this species except its local occurrence in two localities in the watershed of the Wabash and Ohio rivers of extreme south-central and southern Illinois. These localities suggest that it is a species to be expected in those states to the south and east of our borders. The adults are diurnal, with habits like *confusa*. With the exception of two specimens all our adults have been reared; certainly the species is exceedingly uncommon in Illinois. Our rearings indicate that the adults are true members of the spring fauna which emerge about the middle or last of April.

The nymphs have habits similar to those described for *confusa*, which see.

Male.—Length to apex of wings 11 mm.; length to apex of abdomen 8 mm. General color in life is black contrasting with orange-yellow areas. Orange-yellow areas are as follows: small spots between lateral ocelli and compound eyes extending back to pronotum; a small spot in ocellar space extending back to pronotum; a small spot anterior to median ocellus; a median longitudinal stripe on pronotum about one-fifth as wide as pronotum; median stripe and most posterior portions of meso- and metanotum; abdominal tergites except for rows of minute black spots and extreme black lateral margins.

Venter of head, thorax and abdomen essentially orange-yellow with dark fuscous stripes on each side of meso- and metasternum and on extreme lateral margins of abdomen. Tibiae and tarsi black; femora with upper portion black except for a narrow ring of yellow at articulation with tibiae and lower surface fuscous with some yellowish; coxae and trochanters yellowish. Antennae and

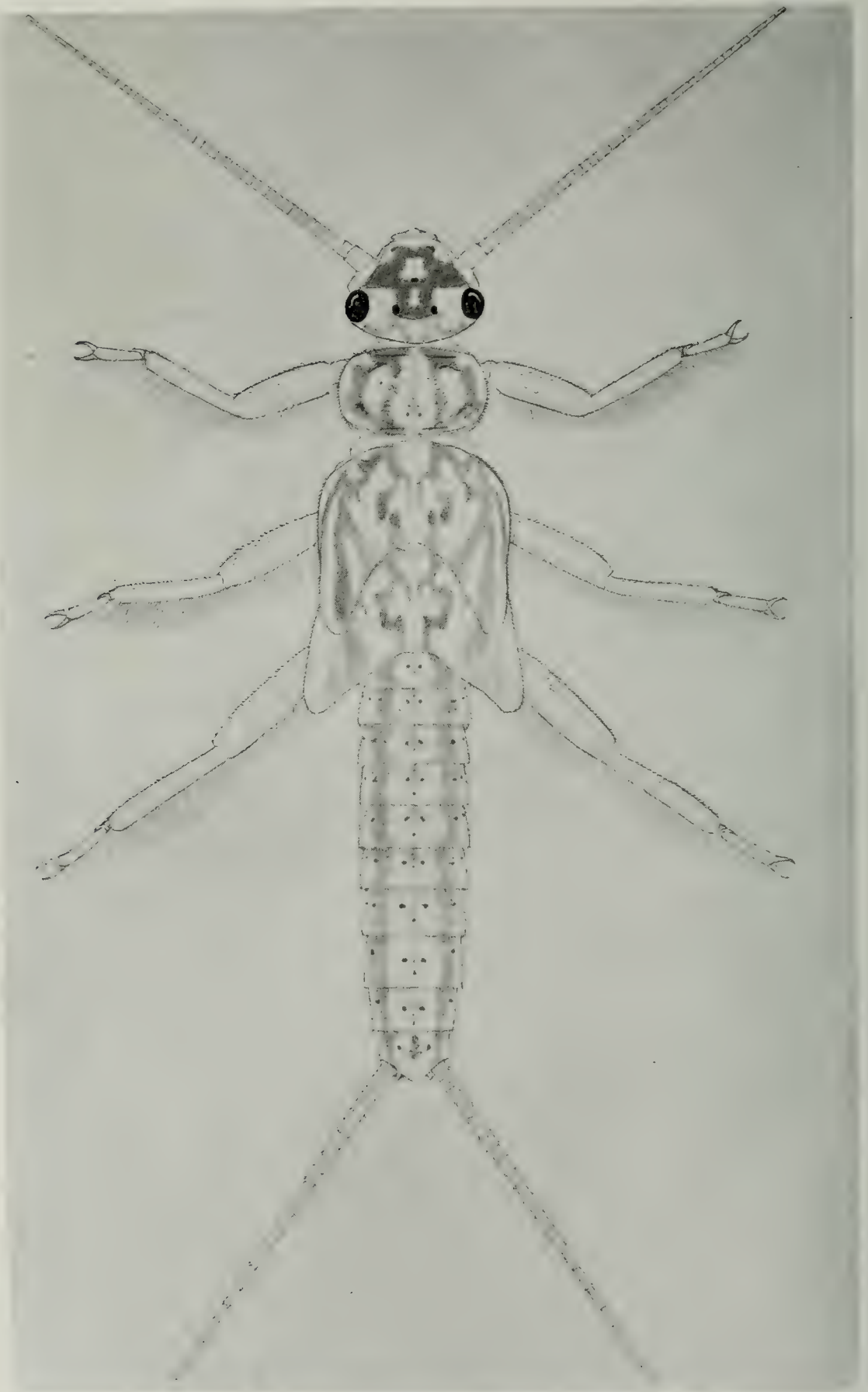


Fig. 343.—*Isoperla mohri*, NYMPHAL FEMALE.

cerci black. Dorsum of abdomen with eight longitudinal rows of minute black spots on orange-yellow background, the two middle and the lateral rows of spots are closely associated so that these spots are paired. Pleurae of thorax essentially black.

In alcohol the adults lose their bright orange-yellow color and become a yellowish brown, and the black areas become dark brown.

No gill remnants on any body area.

Head slightly broader through compound eyes than width of pronotum. Three ocelli nearly forming an equilateral triangle, lateral ocelli about on a line with middle of compound eyes, about as far removed from one another as from compound eyes. Antennae with numerous segments; basal segments wider than long, middle and apical segments longer than wide.

Pronotum approximately quadrangular, much broader than long; angles rather sharp, pronotal flange noticeable on anterior and posterior margins but very faint on lateral margins. A few raised rugosities on the surface, and with a longitudinal smooth depressed stripe about as wide as the distance between lateral ocelli.

Legs with first and second tarsal segments very short, first slightly longer than second, third longer than first and second combined.

Wings long, extending beyond tip of abdomen, up to 9 mm. in length; membrane hyaline, veins very dark and contrasting; venation essentially as in type of genus.

Abdominal tergites without special apical structures. Tenth tergite not cleft, fig. 193. Eighth sternite with a small lobe in middle of posterior margin and ninth sternite strongly produced and turned upwards around tenth sternite so that it is not visible from below, and without a distinct padlike disk near middle of apical portion, fig. 333. Cerci long, many segmented; only extreme basal segments broader than long.

Female.—Length to apex of wings 12 mm.; length to apex of abdomen 10 mm. Head, thorax, abdomen and appendages in general similar to those of male. Differs from male as follows: eighth abdominal sternite, or subgenital plate, with posterior margin slightly produced and rounded and usually but not always slightly notched in middle, fig. 238.

Holotype, male.—Watson, Ill. (trib. of Little Salt cr.): Apr. 27, 1932, reared from nymph collected by T. H. Frison and H. H. Ross.

Allotype, female.—Same data as for holotype.

Paratypes.—Same data as for holotype, 3♂, 7♀. Herod: Apr. 20, 1932, 1♀. Watson: Apr. 19, 1932, 1♀; Apr. 23, 1932, 5♂, 4♀, reared; May 1, 1932, 5♂, 2♀, reared. Collected or reared by T. H. Frison, H. H. Ross, C. O. Mohr.

Nymphal male.—General color yellowish white with dark fuscous pattern upon dorsum of head, thorax and abdomen as shown in fig. 343. This dorsal pattern is featured by the large



Fig. 344.—*Isoperla richardsoni*, NYMPHAL FEMALE.

dark area on head extending as a quadrate shaped portion throughout the ocellar triangle and with an oval light spot in the center, the two conspicuous longitudinal dark stripes on the abdomen, the presence of definite rows of small spots and the absence of scattered freckle-like spots. A median longitudinal dark stripe on the abdominal tergites is reduced to a trace between a pair of closely associated and segmentally arranged minute dark spots in the middle of the tergites. Antennae and cerci yellowish.

Three ocelli nearly forming an equilateral triangle and occupying about same relative position as in the adult. Antennae long, many segmented. No occipital ridge. No pronounced row of stout setae associated with posterior margin of compound eye. Labrum, fig. 52, labium, fig. 142, maxilla, fig. 112, mandibles, fig. 82, and submentum, fig. 162, as illustrated.

Pronotum about twice as wide as long, all angles rounded; marginal groove present on anterior and posterior margins but absent on sides. Wing pads as in fig. 343.

Legs very little flattened and fringe of long fine hairs weakly developed on hind margins of femora, tibiae and tarsi.

Abdomen with color pattern as in fig. 343. Cerci many segmented, not as long as abdomen. Tenth tergite produced backwards and rounded on posterior margin. Eighth tergite with posterior margin straight and setal fringe not interrupted in the middle.

No gills of any type present.

Mature specimens with body length, exclusive of appendages, up to 11 mm.

Nymphal female, fig. 343.—In color and most structural details similar to nymphal male. Eighth abdominal sternite has the setal fringe on posterior margin interrupted in the middle.

Nymphs.—Hill (trib. of Bishop cr.): Apr. 4, 1932. Watson (trib. of Little Salt cr.): Apr. 4, 11, 19, 23, 1932. Collected by T. H. Frison, H. H. Ross, C. O. Mohr. I have also some small nymphs from Little Bourboise creek, St. Claire—Rolla, Mo., collected by H. H. Ross and C. O. Mohr, which are this species.

***Isoperla richardsoni*—NEW SPECIES**

Figs. 53, 83, 113, 143, 197, 235, 344.

This species is named in honor of Mr. R. E. Richardson, formerly of the SURVEY, who first separated the nymphal stage from *I. bilineata* on the basis of its color pattern, while he was sorting bottom fauna collections taken from the Rock river from 1924 to 1927. Later and independently the nymph was again recognized as distinct from *bilineata* and reared. The reared adult produced definite and final proof that the color pattern of the nymph did not represent a case of color variation and that another species was involved.

We know very little about the habits of this species. The adults are probably nocturnal and their mouthparts indicate that they do not feed. Thus far this species has been found only in the Rock river and in association with *bilineata*, for which it would pass in most collections. The nymphs of *richardsoni* however are uncommon in comparison with those of *bilineata* and only careful sorting will reveal their existence. One nymph of this species was collected with a half eaten chironomid larva in its mouth—an indication that it is at least partially or at times carnivorous.

Since the adults resemble in many respects the species *bilineata* and *decepta* and likewise the nymphs have many points in common with other isoperlids, the following descriptions concern only the major points of difference. My practice in the stoneflies of selecting a male as the holotype is reversed here because the subgenital plate of the female offers better recognition characters than does the male. The male, of which I have only one reared specimen, so closely resembles *bilineata* that I have been unable to separate these two species in the key.

Female.—Length to apex of wings 12 mm.; length to apex of abdomen 9 mm. In life this species is essentially yellowish white with some dark or brownish areas and strongly contrasting black ocelli and compound eyes. Superficially it resembles both *I. bilineata* and *decepta*. It differs from *decepta* in having the median and lateral ocelli connected by a dark V shaped line, and from *bilineata* by having the subgenital plate, fig. 235, of the eighth sternite rounded and but slightly produced over the ninth sternite. The mandibles are flabby and not functional as in *bilineata*. Description of the head, thorax, abdomen and appendages of *decepta* fit this species very well except as above stated.

Male.—Similar to female in general color and most morphological details. Apical abdominal segments, fig. 197, so closely resembling the typical *bilineata* that I cannot cite a clear cut difference. It is probable that the lobe on the eighth sternite averages somewhat smaller than in *bilineata* but this is difficult to measure or use as a character for recognition. It is easily separated from *decepta* because of the characteristic V shaped dark line connecting the median and lateral ocelli.

Holotype, female.—Sterling, Ill. (Rock r.): May 10, 1932, reared from nymph collected by T. H. Frison and H. H. Ross.

Allotype, male.—Same data as for holotype.

Paratypes.—Same data as for holotype, 6♀. Grand Detour: May 15, 1930, 1♀. Rockford: May 12, 1927, 1♀. Rock Island: May 16, 1931, 1♀. Collected by T. H. Frison, H. H. Ross, C. O. Mohr, D. H. Thompson.

Nymphal male, fig. 344.—General color pattern whitish yellow with dark colored areas as in the figure. Some minute paired dark spots longitudinally arranged on abdominal tergites

but freckle-like spots absent. Venter without conspicuous dark markings. Appendages colored essentially as venter. Size about the same as for *decepta*.

Head with ocelli arranged approximately as in *decepta*. No occipital ridge. No conspicuous row of stout setae associated with posterior margin of compound eye. Labrum, fig. 53, labium, fig. 143, maxilla, fig. 113, and mandibles, fig. 83, as illustrated.

Pronotum and legs approximately as in *decepta*.

Abdomen marked as in fig. 344. Three longitudinal stripes on tergites distinct. Cerci about as long as abdomen, many segmented; segments progressively longer apically. Apical segments approximately as in *decepta*.

No gills of any type.

Nymphal female.—Similar to male in general color and most morphological details. Eighth abdominal sternite with transverse row of setae on posterior margin interrupted in the middle.

Nymphs.—Camp Grant (Rock r.): May 7, 1926. Dixon (Rock r.): Apr. 3, 1928. Oregon (Rock r.): May 15, 1926; May 26, 1927; Apr. 3, 1928. Rockford (Rock r.): Apr. 21, May 4–6, 1926; Apr. 26, May 12, 1927. Rock Island (Rock r.): Apr. 3, 1928; Apr. 27, May 9, 1932. Rockton (Rock r.): May 16, 1926. Sterling (Rock r.): May 13–15, 1925; Apr. 27, 1932. Collected by T. H. Frison, H. H. Ross, C. O. Mohr, D. H. Thompson.

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INDEX

Page numbers in this index are for the occurrence of the names in the catalog of species, pp. 307-461, only. Numbers in light face type refer to mere mention of the name or its location without discussion; numbers in bold face show locations of discussions or keys in the case of families and genera, and discussion or collection records for species. Placement of names in keys and in explanation of figures is not indexed.

A

- abnormis, *Acroneuria* 311, 388, 389, **391-95**, 407
Perla 391
Acroneuria 310, 311, 372, 373, **388-91**, 409
 abnormis 311, 388, 389, **391-95**, 407
 arenosa 388, 389, 397
 arida 311, 389, **395-401**, 405
 evoluta 389, 395, 397, 398
 internata 311, 389, **401-03**
 pennsylvanica 391, 393
 rupinsulensis 394, 403
 ruralis 311, 389, 394, **403-05**
 sp. a 311, 389, **405**
 sp. b 311, 389, **407**
 albidipennis, *Nemoura* 351
Allocapnia 310, 311, 336, 337, 347, 354, 355, **357-63**, 387, 390
 forbesi 311, **363**, 364, 370
 cornuta 311, **363-64**
 granulata 311, 357, **364-65**, 366
 illinoensis 311, **365-66**
 incisura 360
 mystica 311, **366-67**
 pygmaea 311, 364, **367**
 recta 311, 364, **367-70**
 vivipara 311, 357, **370-72**, 386
Alloperla 310, 427, 431
Amphinemura 349
 annulipes, *Neophasganophora* 407
 apicalis, *Chloroperla* 429
 arenosa, *Acroneuria* 388, 389, 397
Perla 388
 arida, *Acroneuria* 311, 389, **395-401**, 405
Perla 395
Atoperla 310, 311, 372, **377**, 380
 ephyre 311, **377**, 380, 381

B

- bilineata, *Isoperla* 308, 311, 411, 428, 431, 432, **437-39**, 441, 445, 447, 448, 449, 455, 459, 460

Perla 431, 437

Sialis 437

bilobata, *Isoperla* 449

brevicauda, *Capnia* 309

brunnipennis, *Chloroperla* 386

C

capitata, *Neophasganophora* 311, 407, **409-12**, 414

Perla 407, 409

Capnella 357

granulata 357, 364

recta 367

vivipara 370

Capnia 310, 311, 355, **356**, 357, 371, 390

brevicauda 309

minima? 357, 370, 371

nigra 356

species 311

vernalis 356, 357

vernalis? 311, **356-57**

Capniidae 307-11, 352, **355-56**, 373

Capnura 310, 355

Chloroperla 310, 311, 427, **429**, 431

apicalis 429

brunnipennis 386

clymene 381

cydippe 311, 429, **431**, 451

minuta 453

nana 433, 453

Chloroperlidae 307-11, 372, 416, **427-29**

cinctipes, *Perlesta* 384

claasseni, *Leuctra* 311, **354-55**

clio, *Clioperla* 439

Isogenus 439

Isoperla 311, **439-41**, 443, 445

Clioperla 428, 432, 438, 451

clio 439

clymene, *Chloroperla* 381

Neoperla 311, **381-84**, 386

colubrinus, *Isogenus* 418

colubrinus?, *Isogenus* 418

completa, *Nemoura* 351

confusa, *Isoperla* 311, 432, 433, **441-45**,
451, 455
conspicua, *Isoperla* 311, 432, 441, **445-47**
cornuta, *Allocaonia forbesi* 311, **363-64**
crosbyi, *Hydroperla* 311, 416, **419-23**,
424, 426, 427, 441
Perla 417, 419
cydippe, *Chloroperla* 311, 429, **431**, 451
Isopteryx 431

D

decepta, *Isoperla* 308, 311, 432, 438,
441, **447-49**, 455, 460, 461
decipiens, *Perla* 386
Diploperla 428, 432, 449, 451
Doddsia 310
dorsata, *Pteronarcys* 336, 339
duplicata, *Isoperla* 428, 432, 433, **449-53**
Perla 427, 428, 449
drymo, *Perla* 380
Perlinella 311, **380-81**

E

elongata, *Perla* 380
ephyre, *Atoperla* 311, **377**, 380, 381
Perla 377
Eucapnopsis 310, 352, 354
evoluta, *Acroneuria* 389, 395, 397, 398

F

fasciata, *Semblis* 347
Strophopteryx 311, **347**
Taeniopteryx 348
Filipalpia 308-10
flavescens, *Neophasganophora* 407
Perla 409
flaviventris, *Hemimelaena* 416
forbesi, *Allocaonia* 311, **363**, 364, 370
cornuta, 311, **363-64**
frontalis, *Isogenus* 416, 418
fugitans, *Perla* 423
fumipennis, *Perla* 377, 380, 381
fumosa, *Perla* 407

G

geniculata, *Leuctra* 354
granulata, *Allocaonia* 311, 357, **364-65**,
366
granulata, *Capnella* 357, 364

H

harti, *Hydroperla* 311, 416, **423-26**, 427,
445
Hemimelaena 416, 427
flaviventris 416
Holognatha 308-10
Hydroperla 310, 311, 416, **417-19**, 427,
411
crosbyi 311, 416, **419-23**, 424, 426,
427, 441
harti 311, 416, **423-26**, 427, 445
postica 427
varians 311, 416, **426-27**

I

illinoensis, *Allocaonia* 311, **365-66**
illustris, *Neophasganophora* 407
immarginata, *Togoperla* 409, 412
incisura, *Allocaonia* 360
internata, *Acroneuria* 311, 389, **401-03**
Perla 401
Isogenoides 416
Isogenus 310, 416, 417, 418
clio 439
colubrinus 418
colubrinus? 418
frontalis 416, 418
postica 416
Isoperla 310, 311, 354, 390, 427, 428,
429, **431-37**
bilineata 308, 311, 411, 428, 431, 432,
437-39, 441, 445, 447, 448, 449, 455,
459, 460
bilobata 449
clio 311, **439-41**, 443, 445
confusa 311, 432, 433, **441-45**, 451, 455
conspicua 311, 432, 441, **445-47**
decepta 308, 311, 432, 438, 441, **447-**
49, 455, 460, 461
duplicata 428, 432, 433, **449-53**
minuta 311, 432, 433, 438, 441, **453-55**
mohri 311, 432, 438, **455-59**
richardsoni 311, 432, 438, 447, **459-61**
sobria 445
Isopteryx 429, 431
cydippe 431

K

kansensis, *Perla* 415
Kathroperla 310, 427

L

Leuctra 309-11, 337, 352, **354**, 390
 claasseni 311, **354-55**
 genuiculata 354
 Leuctridae 307-11, **352-54**
 limbata, Perla 412
 Togoperla 412

M

maura, Taeniopteryx 340, 341
 media, Perla 407, 412
 Togoperla 311, 409, **412-14**
 Megaleuctra 309, 310, 352
 minima?, Capnia 357, 370, 371
 minuta, Chloroperla 453
 Isoperla 311, 432, 433, 438, 441, **453-55**
 mohri, Isoperla 311, 432, 438, **455-59**
 mystica, Allocapnia 311, **366-67**

N

nana, Chloroperla 433, 453
 nebulosa, Nemoura 340
 Taeniopteryx 340
 Nemoura 309-11, 337, **349**, 354, 390
 albidipennis 351
 completa 351
 nebulosa 340
 nivalis 341
 perfecta 352
 variegata 349
 venosa 311, **349-52**
 Nemouridae 307-11, 339, **349**, 352
 Nemura 349
 Neoperla 310, 311, 372, **381**
 clymene 311, **381-84**, 386
 Neophasganophora 310, 311, 372, **407-09**, 412
 annulipes 407
 capitata 311, 407, **409-12**, 414
 flavescens 407
 illustris 407
 nigra, Capnia 356
 nivalis, Nemoura 341
 Taeniopteryx 311, 340, **341-45**, 347, 348, 386
 nobilis, Pteronarcys 311, **336-39**

O

occipitalis, Perla 381
 occipitalis?, Perla 381

P

Paraperla 310, 427
 parvula, Taeniopteryx 311, 340, **345-47**
 Peltoperla 310
 Peltoperlidae 307-10
 pennsylvanica, Acroneuria 391, 393
 Perla 391, 393, 394
 perfecta, Nemoura 352
 Perla 372, 373, 388, 407, 409, 418, 449
 abnormis 391
 arenosa 388
 arida 395
 bilineata 431, 437
 capitata 407, 409
 crosbyi 417, 419
 decipiens 386
 drymo 380
 duplicata 427, 428, 449
 elongata 380
 ephyre 377
 flavescens 409
 fugitans 423
 fumipennis 377, 380, 381
 fumosa 407
 internata 401
 kansensis 415
 limbata 412
 media 412
 occipitalis 381
 occipitalis? 381
 pennsylvanica 391, 393, 394
 placida 384, 386
 postica 427
 producta 377, 378
 ruralis 403
 trivittata 380
 varians 426
 Perlesta 310, 311, 372, **384**
 cinctipes 384
 placida 311, 381, 384, **386-88**
 virginica 384
 Perlidae 307-11, **372-77**, 416
 Perlinella 310, 311, 372, 377, **380**
 drymo 311, **380-81**
 Perlodes 310, 416, 417, 418
 Perlodidae 307-11, 372, **416-17**, 427
 Perlodini 339
 Perlomyia 310, 352
 Phasganophora 407
 placida, Perla 384, 386
 Perlesta 311, 381, 384, **386-88**

postica, *Hydroperla* 427

Isogenus 416

Perla 427

producta, *Perla* 377, 378

Pseudoperla 381

Pteronarcella 310, 334, 336

Pteronarcidae 307-11, 334

Pteronarcinae 339

Pteronarcys 310, 311, 334, 336

dorsata 336, 339

nobilis 311, 336-39

regalis 336

pygmaea, *Allocaenia* 311, 364, 367

Semblis 367

R

recta, *Allocaenia* 311, 364, 367-70

Capnella 367

regalis, *Pteronarcys* 336

richardsoni, *Isoperla* 311, 432, 438, 447, 459-61

rupinsulensis, *Acroneuria* 394, 403

ruralis, *Acroneuria* 311, 389, 394, 403-05

Perla 403

S

Semblis fasciata 347

pygmaea 367

Setipalpia 308-10

Sialis bilineata 437

sobria, *Isoperla* 445

species, *Capnia* 311

sp. a, *Acroneuria* 311, 389, 405

Togoperla 311, 414-16

sp. b, *Acroneuria* 311, 389, 407

Strophopteryx 310, 311, 337, 339, 347, 360

fasciata 311, 347

Subulipalpia 308-10

Systellognatha 308-10

T

Taenionema 310

Taeniopterygidae 307-11, 339-40, 352 373

Taeniopteryx 309-11, 337, 339, 340-41, 347, 360

fasciata 348

maura 340, 341

nebulosa 340

nivalis 311, 340, 341-45, 347, 348, 386

parvula 311, 340, 345-47

Togoperla 310, 311, 372, 409, 412

immarginata 409, 412

limbata 412

media 311, 409, 412-14

sp. a 311, 414-16

trivitatta, *Perla* 380

V

varians, *Hydroperla* 311, 416, 426-27

Perla 426

variegata, *Nemoura* 349

venosa, *Nemoura* 311, 349-52

vernalis, *Capnia* 356, 357

vernalis?, *Capnia* 311, 356-57

virginica, *Perlesta* 384

vivipara, *Allocaenia* 311, 357, 370-72, 386

Capnella 370

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Vol. XX

BULLETIN

Article V

Annotated List of the Fishes of Illinois

D. JOHN O'DONNELL



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URBANA, ILLINOIS
AUGUST 1935

STATE OF ILLINOIS
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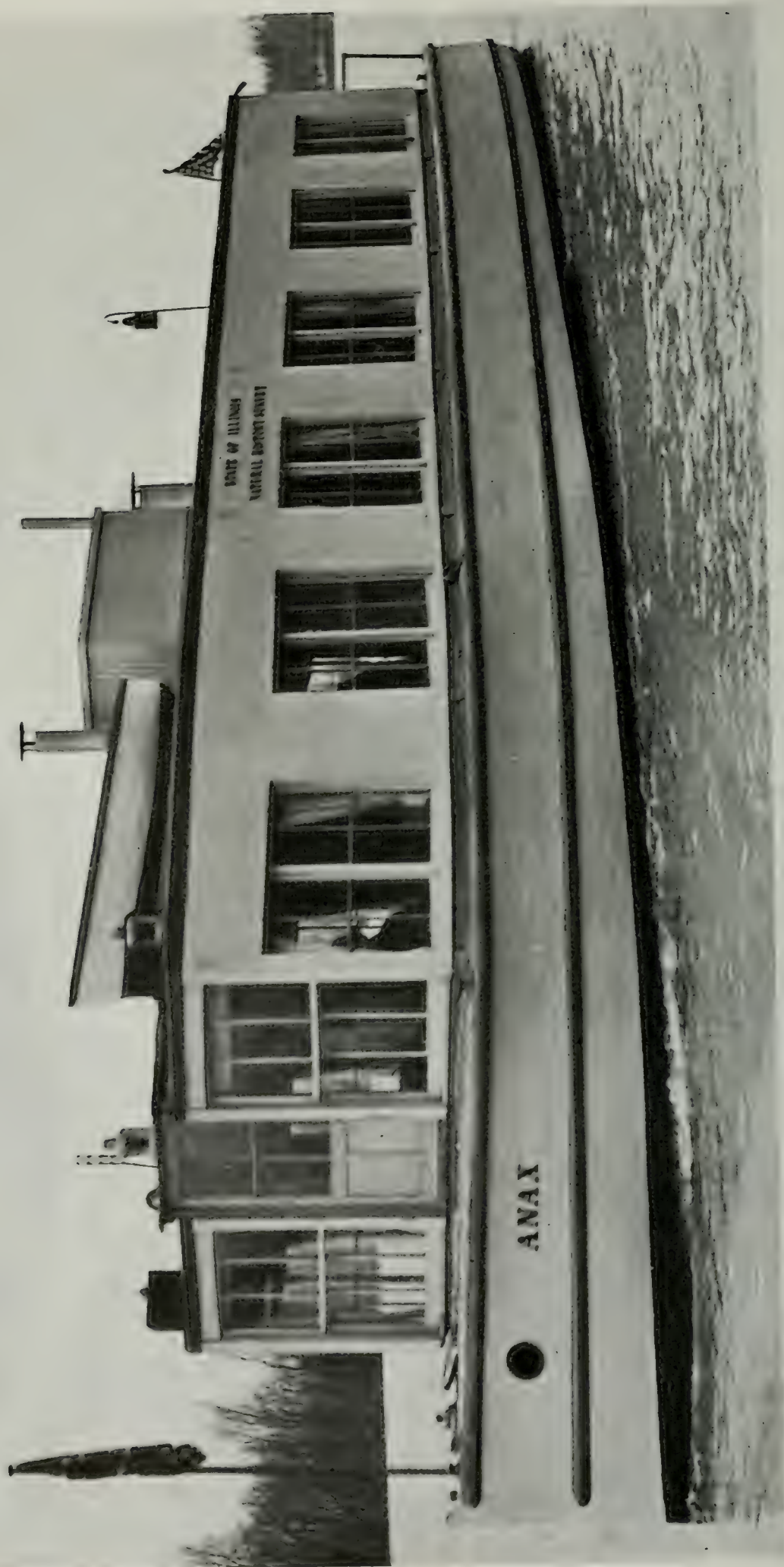
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This paper is a contribution from the Section of Aquatic Biology

CONTENTS

	PAGE
INTRODUCTION.....	473
CLASSIFIED LIST OF ILLINOIS FISHES.....	475
BIBLIOGRAPHY.....	491
APPENDIX.....	492
Hybridization and racial differentiation among Illinois fishes.—Index to families, genera and species.	



SURVEY LABORATORY BOAT ANAX ON THE ILLINOIS RIVER AT HAVANA

Annotated List of the Fishes of Illinois

D. JOHN O'DONNELL

SINCE 1876, specimens and data regarding the appearance and distribution of fishes in this state have been collected by zoologists of the ILLINOIS STATE NATURAL HISTORY SURVEY and the organizations which were its predecessors. In 1909 Stephen Alfred Forbes and Robert Earl Richardson published a report entitled "The Fishes of Illinois," which was partly revised for a second edition printed in 1920¹. Many scientific names of Illinois fishes have been changed in the twenty-six years that have passed since the original report was issued, so that today there is need for a list which will place the state fauna in accord with present general classifications.

Present Fauna

In recording the many changes that have been made by taxonomists, this list presents 172 species names, distributed among 31 families and 117 genera. In addition there are several dozen hybrid forms in the fish fauna of Illinois.

Ten species have been added to the forms known to Forbes and Richardson in 1909, some of which are names of American and foreign species that have become established in Illinois, and some native species previously undiscovered.

Jordan Nomenclature

Because of its general usage, the manual of Jordan (1929), which changed the generic names associated with 70 species and the specific names of 31 species of fishes given in Forbes & Richardson, has furnished the nomenclature for this list. Names in the list by Jordan, Evermann and Clark (1930), as well as the old names of Forbes & Richardson (1920), are used in synonymy.

Names of Hybrids

There are a few exceptions to this rule. One, of course, is the case of certain hybrids, which Jordan did not recognize but which have nevertheless been classified and used separately, either by Forbes and Richardson in 1909 or subsequently in Jordan, Evermann & Clark (1930). *Apomotis* (*Lepomis*) *ischyrus*, *A.* (*Lepomis*) *euryorus* and *Notropis piisbryi* are in this group. Likewise *Carpiodes thompsoni*, not recognized by Jordan and now probably best treated as a variety of *C. cyprinus*, is included in this list because it has been established in the literature of the Illinois fauna (Forbes & Richardson 1920), in addition to its placement as a distinct species in Jordan, Evermann & Clark (1930). *Alvordius* (*Hadropterus*) *evermanni* was included in Forbes & Richardson on the basis of a single

¹See bibliography, p. 491.



Fig. 1.—Interior of SURVEY laboratory boat Anax, looking forward.

specimen taken in the Illinois. Possibly a suspicion of its hybrid nature, as stated by Hubbs (1926), accounts for its omission from Jordan (1929). It recurs as valid, however, in Jordan, Evermann & Clark, on the strength of specimens from Indiana. The last exception is in the case of the red horses, whose names of Forbes & Richardson are retained. The descriptions of red horses given in Jordan (1929) and in Jordan, Evermann & Clark (1930), do not approximate our Illinois red horses closely enough to make their identity probable.

Forbes & Richardson Accurate

It has never been adequately emphasized that changes in the nomenclature of

Illinois fishes have resulted entirely from the formalities of fish taxonomy and not from correction of any mistakes in segregation or identifications as used in 1903-06 by Forbes and Richardson. Neither have they resulted from any evolution of our species, nor from any refinement in the method of describing them. The descriptions which were written for "The Fishes of Illinois" were, in almost every case, based on the detailed examination and measurement of large numbers of Illinois specimens.

Common Names in Illinois

Lack of agreement among ichthyologists in regard to common names of fishes has forced the adoption in this list of those

common names which are now in most general use in Illinois. These common names and the recorded distributions have been included as far as known; it is hoped that this effort will stimulate others interested in the fish life of the state to fill the obvious gaps in many of the records.

Acknowledgments

This report is based upon field records kept by SURVEY zoologists and their fore-runners, since 1876. A great deal of in-

formation and assistance have been contributed by present staff members, among them Dr. T. H. Frison, chief; Dr. David H. Thompson, zoologist; and Mr. F. D. Hunt, field naturalist, to all of whom the writer tenders thanks. An indebtedness is also acknowledged to Dr. Harley Jones Van Cleave, professor of zoology in the University of Illinois, for his suggestion of the problem while expressing a need among ichthyologists and less technical students for such a list.

CLASSIFIED LIST OF ILLINOIS FISHES

PETROMYZONIDAE

Ichthyomyzon Girard

I. concolor (Kirtland) J JEC FR 9²

LAMPER, LAMPER EEL, LAMPREY.—All Illinois streams with a drainage area exceeding 1000 square miles. Parasitic in winter on larger fishes such as carp, buffalo, catfishes and spoonbill. Three or more lampers may occasionally be found on one host fish.

Lethenteron Creaser & Hubbs

L. appendix (De Kay) J JEC

Lampetra wilderi Gage FR 11

BROOK LAMPREY, SMALL BLACK LAMPREY.—Very rare; Lake Michigan 1903, small creek near Danville winter of 1931. Numbers observed spawning on rocky riffles of Wild Cat creek near Dayton (Tippecanoe county), Ind., in early spring of 1910, 1916.

POLYODONTIDAE

Polyodon Lacépède

P. spathula (Walbaum) J JEC FR 16

SPOONBILL CAT, PADDLEFISH, BONELESS CAT.—Large rivers; recently found in the

Mississippi, Ohio, Wabash, Illinois river to Henry, Rock river to Sterling, Kaskaskia river to Evansville. Everywhere less abundant than formerly. Almost absent from the upper Mississippi following construction of Keokuk dam.

ACIPENSERIDAE

Acipenser Linnaeus

A. fulvescens Rafinesque J JEC

Acipenser rubicundus Le Sueur FR 24

ROCK STURGEON, LAKE STURGEON.—Taken occasionally in the Mississippi, Ohio, Wabash and Rock rivers. Common in the Illinois river before 1900; now rare.

Scaphirhynchus Heckel

S. platyrhynchus (Rafinesque) J JEC FR 27

SHOVEL-NOSED STURGEON, HACKLEBACK.—Common in the Mississippi and Ohio rivers. Occasionally taken in the lower Illinois.

Parascaphirhynchus Forbes & Richardson

P. albus Forbes & Richardson J JEC FR 28

WHITE STURGEON, LONG-NOSED STURGEON.—Rare; known only from the Mississippi river at Grafton and Alton.

²J indicates the present accepted name as given by Jordan (1929); JEC indicates the name given by Jordan, Evermann & Clark (1930); and FR, with a number, indicates the page on which the species is given in Forbes & Richardson (1920).



Fig. 2.—Principal streams of Illinois.

LEPISOSTEIDAE

Lepisosteus Lacépède

L. osseus (Linnaeus) *J JEC FR 31*

LONG-NOSED GAR, BILLY GAR.—Lakes. Found in all streams with drainage area exceeding 500 square miles.

Cylindrosteus Rafinesque

C. platostomus (Rafinesque) *J JEC*

Lepisosteus platostomus Rafinesque *FR 34*

SHORT-NOSED GAR.—Most abundant gar in rivers with drainage area of more than 5000 square miles.

Atractosteus Rafinesque

A. tristoechus (Schneider) *J*

Atractosteus spatula (Lacépède) *JEC. Lepisosteus tristoechus* (Bloch & Schneider)

FR 35

ALLIGATOR GAR.—Mississippi river to Quincy. Occasionally in the Illinois to Henry, the Ohio, lower Wabash and lower Kaskaskia.

AMIIDAE

Amia Linnaeus

A. calva Linnaeus *J JEC FR 38*

DOGFISH, GRINDLE, BOWFIN.—Sloughs and lakes adjoining the Mississippi, Illinois and Ohio rivers. Not so abundant northward. Fox, Rock and Kankakee rivers. Occurs in the larger and more sluggish streams of southern Illinois.

HIODONTIDAE

Amphiodon Rafinesque

A. alosoides (Rafinesque) *J JEC*

Hiodon alosoides (Rafinesque) *FR 43*

NORTHERN MOONEYE, GOLDEYE.—Very rare; found only in the largest streams, and prefers swift open water. At one time abundant in the Mississippi and Ohio rivers, and the Illinois to Havana.

Hiodon Le Sueur

H. tergisus Le Sueur *J JEC FR 44*

TOOTHED HERRING, MOONEYE.—Occurs in small numbers in the Rock river

to Beloit, Illinois river to Henry, Kaskaskia and Wabash rivers. Very abundant in the Mississippi and Ohio.

CLUPEIDAE

Pomolobus Rafinesque

P. chrysochlorus Rafinesque *J JEC FR 48*

SKIPJACK, GOLDEN SHAD, BLUE HERING.—Not common in Illinois, a few having been taken from the lower Rock and lower Illinois rivers. Present in small numbers in the Mississippi and Ohio.

Alosa Linck

A. ohioensis Evermann *J JEC FR 49*

OHIO SHAD.—Rare; present in small numbers in the Mississippi and the Ohio to Pittsburgh. May occur in the Illinois up to Meredosia.

DOROSOMIDAE

Dorosoma Rafinesque

D. cepedianum (Le Sueur) *J JEC FR 45*

GIZZARD SHAD, HICKORY SHAD.—Abundant; generally distributed in all larger rivers, connecting lakes and occasionally smaller streams. Abundant in lakes having mud bottom.

COREGONIDAE

Prosopium Milner

P. quadrilaterale (Richardson) *J JEC*

Coregonus quadrilateralis Richardson *FR 53*

MENOMINEE WHITEFISH, ROUND WHITEFISH.—Lake Michigan. Much more rarely taken than the common whitefish.

Coregonus Linnaeus

C. clupeaformis (Mitchill) *J JEC FR 51*

COMMON WHITEFISH, SUPERIOR WHITEFISH.—Fairly abundant in southwestern Lake Michigan. Largest and most widely known of our species of whitefish.

Leucichthys Dybowski**L. artedi** (Le Sueur) *J JEC**Argyrosomus artedi* (Le Sueur) *FR 54*

CISCO, LAKE HERRING, COMMON LAKE HERRING.—Lake Michigan. The most abundant food fish in the Great Lakes. In addition to the cisco, the following are more or less commonly taken in Lake Michigan: *L. reighardi* Koelz, the chub *L. zenithicus* (Jordan & Evermann), the longjaw *L. alpenae* Koelz, the mooneye cisco *L. hoyi* (Gill), *L. johannae* (Wagner), the mooneye *L. kiyi* Koelz, and the blackfin *L. nigripinnis* (Gill).

SALMONIDAE**Salmo** Linnaeus**S. salar sebago** Girard *J JEC*

LANDLOCKED SALMON, SEBAGO SALMON.—Lake Michigan: found in small numbers at the northern end; may also occur off Chicago.

Trutta Linnaeus**T. trutta** (Linnaeus) *J JEC*

GERMAN BROWN TROUT.—A few have been reported by anglers from the tributaries of the Kishwaukee and Pecatonica rivers. It is uncertain whether this trout is able to propagate itself in natural waters of Illinois.

T. iridea (Gibbons) *J**Salmo irideus* Gibbons *JEC*

RAINBOW TROUT.—Common off Indiana and Michigan shores of Lake Michigan. To be expected off the Illinois shore. Probably not separable from *Salmo gairdnerii* Richardson.

Cristivomer Gill & Jordan**C. namaycush** (Walbaum) *J JEC FR 56*

LAKE TROUT.—Fairly abundant in Lake Michigan off the Illinois shore.

Salvelinus Richardson**S. fontinalis** (Mitchill) *J JEC*

EASTERN BROOK TROUT, SPECKLED TROUT.—In Franklin spring seven miles northwest of Rockford, and in spring-fed

tributaries of the Kishwaukee, Pecatonica and Apple rivers. Is able to propagate itself in these localities. Also found in Blackberry creek near Yorkville but not propagating.

ANGUILLIDAE**Anguilla** Thunberg**A. bostoniensis** Le Sueur *J*

Anguilla rostrata (Le Sueur) *JEC*. *Anguilla chrysypa* Rafinesque *FR 59*

AMERICAN EEL, FRESH-WATER EEL.—Found in all streams having a drainage basin exceeding 500 square miles. Up to several hundred pounds taken per day by commercial fishermen at Browning on the Illinois.

CATOSTOMIDAE**Cycleptus** Rafinesque**C. elongatus** (Le Sueur) *J JEC FR 65*

MISSOURI SUCKER, BLACK HORSE, BLUEFISH.—Mississippi, Ohio and lower Illinois rivers. Formerly common in the lower Rock.

Megastomatobus Fowler**M. cyprinella** (Cuvier & Valenciennes) *J JEC*

Ictiobus cyprinella (Cuvier & Valenciennes) *FR 68*

RED-MOUTH BUFFALO, BIG-MOUTH BUFFALO.—Very abundant in all larger streams and floodplain lakes. Found in the smaller, more sluggish streams with drainage areas exceeding 300 square miles. Second among Illinois commercial fishes.

Ictiobus Rafinesque**I. urus** (Agassiz) *J JEC FR 70*

MONGREL BUFFALO, ROUND BUFFALO.—Distribution same as big-mouth buffalo but it is less abundant. Present known facts concerning the life history of this fish permit the interpretation that it is a natural hybrid between *Megastomatobus cyprinella* and *I. bubalus*.

I. bubalus (Rafinesque) *J JEC FR 72*

SMALL-MOUTH BUFFALO, QUILLBACK

BUFFALO, HIGHBACK BUFFALO, RAZOR-BACK BUFFALO.—Common in the Mississippi, Ohio, Illinois and Rock, and in the principal streams of the state generally. Prefers deep water. Characteristically a channel fish although common in some bottomland lakes and sloughs. Commercially important.

Carpiodes Rafinesque

C. carpio (Rafinesque) *J JEC FR 76*

COMMON RIVER CARP, SHAD, SILVEREEN.—Common in the Illinois, Rock and Mississippi. Seldom ascends smaller streams.

C. difformis Cope *J JEC FR 77*

BLUNT-NOSED RIVER CARP.—Common in some smaller streams of central Illinois. Taken sparingly in the Rock and Illinois rivers.

C. cyprinus (Le Sueur) *J JEC*

Carpiodes velifer (Rafinesque) *FR 78*

QUILLBACK, SILVER CARP.—Common in medium-sized rivers and larger creeks. Most abundant in northern Illinois. Avoids area of the lower Illinoisan glaciation.

C. thompsoni Agassiz *JEC FR 79*

LAKE CARP.—Found in the Great Lakes. Its recognition by Forbes and Richardson from the Illinois river is questioned. A recent examination of this genus by the late Mr. R. E. Richardson and Dr. David H. Thompson, using a large amount of fresh material including specimens from several points on the Great Lakes and other parts of the United States, indicates that *C. thompsoni* should be regarded as a variety of *C. cyprinus*.

Catostomus Le Sueur

C. catostomus (Forster) *J JEC FR 84*

LONG-NOSED SUCKER, NORTHERN SUCKER, RED SUCKER.—Lower Lake Michigan.

C. commersonii (Lacépède) *J JEC FR 85*

BLACK SUCKER, FINE-SCALED SUCKER, COMMON SUCKER.—Generally distributed throughout Illinois. Most abundant in the northern third of the state, especially

in the smaller rivers and larger creeks. Common in Lake Michigan.

Hypentelium Rafinesque

H. nigricans (Le Sueur) *J JEC*

Catostomus nigricans Le Sueur *FR 86*

HOG SUCKER, HAMMERHEAD, STONE-ROLLER.—Common throughout northern and eastern parts of the state in headwaters of the smaller tributaries of the Illinois, Kaskaskia, Embarrass and Big Vermilion rivers. Prefers swifter streams with gravel bottom.

Erimyzon Jordan

E. sucetta oblongus (Mitchill) *J FR 81*

Erimyzon sucetta (Lacépède) *JEC*. *Erimyzon oblongus* (Mitchill) *JEC*

CHUB SUCKER, SWEET SUCKER.—Widely distributed in large and small streams. Essentially a creek species. Most abundant in eastern part of the state in the drainage of the Wabash and Ohio, and in the headwaters of the Sangamon and Kaskaskia. Common in the Fox lakes.

Minytrema Jordan

M. melanops (Rafinesque) *J JEC FR 83*

SPOTTED SUCKER, STRIPED SUCKER.—Taken in all stream systems, but most commonly in the Wabash and the Kaskaskia basins. Mainly a species of creeks and smaller rivers. Most abundant in certain lakes and ponds.

Moxostoma Rafinesque

M. anisurum (Rafinesque) *J JEC FR 89*

WHITE-NOSED SUCKER.—Lake Michigan and the Illinois, Sangamon, Rock, Mississippi, Ohio and Wabash. Distributed throughout the state in moderate numbers.

M. aureolum (Le Sueur) *J JEC FR 90*

COMMON RED HORSE.—Taken in all streams except the Big Muddy. Commonest in the northern and eastern two thirds of the state. Abundant in the Rock river basin and in the Kaskaskia, Wabash and Sangamon systems.

M. lesueurii (Richardson) *J JEC*

Moxostoma breviceps (Cope) *FR 91*

SHORT-HEADED RED HORSE.—All rivers, lakes and streams of the central and northern part. More abundant in the smaller rivers than in large rivers, creeks and lakes.

Placopharynx Cope

P. carinatus Cope *J JEC*

Placopharynx duquesnei (Le Sueur) *FR 93*

BIG-TOOTHED RED HORSE.—Rare in Illinois. One specimen from the Wabash, several from the Illinois. Not recognized with certainty in recent years.

^L
Hagochila Jordan & Brayton

^L
H. lacera Jordan & Brayton *FR 94*

RABBIT-MOUTH SUCKER.—Up to the present not found in Illinois. Probably inhabits the Wabash basin.

CYPRINIDAE

Cyprinus (Artedi) Linnaeus

C. carpio Linnaeus *J³ FR 104*

EUROPEAN CARP.—Common or abundant in all streams draining more than 200 square miles. It is very abundant in the Illinois river and its connecting bottomland lakes. The carp is the most important commercial fish of the Illinois, the annual catch being 6 to 10 million pounds.

Carassius Nilsson

C. auratus (Linnaeus) *J*

GOLDFISH.—Rarely taken from the Illinois river and Lake Michigan. Common in Wolf lake near Chicago. Three specimens of a hybrid *Carassius auratus* × *Cyprinus carpio* have been taken, two from the Illinois at Peoria in 1932 and one from the Rock at Rockford, Feb. 1, 1933.

Chrosomus Rafinesque

C. erythrogaster Rafinesque *J JEC FR 112*

RED-BELLIED DACE.—Locally abundant. Occurs in small, clear, spring-fed tributaries of the Rock and Fox rivers. Found

occasionally in small spring-fed streams of southern Illinois. Does not occur within the lower Illinoisan glaciation.

Notemigonus Rafinesque

N. crysoleucas (Mitchill) *J JEC*

Abramis crysoleucas (Mitchill) *FR 126*

GOLDEN SHINER, BREAM, ROACH.—Found in all streams. In the southern and eastern parts of the state it prefers creeks. Elsewhere it has been taken in greatest numbers along the larger rivers.

Opsopoeodus Hay

O. emiliae Hay *J JEC FR 124*

Most abundant in southern Illinois, especially in the Saline river. Prefers creeks and ponds. Northward it has been taken almost wholly along the larger rivers—the Illinois, the Rock and Mississippi.

Semotilus Rafinesque

S. atromaculatus (Mitchill) *J JEC FR 121*

HORNED DACE, CREEK CHUB.—Equally abundant in all the stream systems of Illinois. Prefers creeks and the smaller rivers.

Rhinichthys Agassiz

R. cataractae (Cuvier & Valenciennes) *J JEC FR 160*

LONG-NOSED DACE.—Rare; found only in Big creek near Anna, and near Waukegan. Prefers clear cold streams.

R. atronasus (Mitchill) *J JEC FR 162*

BLACK-NOSED DACE.—Rare; has been taken only in creeks of the northern part of the state, the Fox river, and from Big creek (two specimens) near Anna.

Extrarius Jordan

E. hyostomus (Gilbert) *J*

Macrhybopsis hyostoma (Gilbert) *JEC*

Hybopsis hyostomus (Gilbert) *FR 163*

Taken in moderate numbers from the Rock, Green, Illinois and Mississippi.

Macrhybopsis Cockerell & Alliston

M. gelidus (Girard) *J*

Macrhybopsis gelida (Girard) *JEC*

³See Jordan (1929), p. 67, footnote.

Newly discovered in Illinois. Several specimens were taken in February 1930 from the Mississippi river at Chester.

Erimystax Jordan

E. dissimilis (Kirtland) *J JEC*

Hybopsis dissimilis (Kirtland) *FR 164*

SPOTTED SHINER.—Rare; found in the lower Kaskaskia, upper Embarrass, the Sangamon, Kickapoo, Spoon and Rock.

Erinemus Jordan

E. hyalinus (Cope) *J JEC*

Hybopsis amblops (Rafinesque) *FR 165*

SILVER CHUB, BIG-EYED CHUB.—Abundant in the southeastern part, also in the Mackinaw and upper Kankakee rivers. Prefers creeks. Restricted in central Illinois to the Middle Fork, Salt Fork and Embarrass river basins.

E. storerianus (Kirtland) *J JEC*

Hybopsis storerianus (Kirtland) *FR 166*

STORER'S CHUB.—Scarce. Widely distributed in the larger streams and lowland lakes. Not present in streams of the lower Illinoisan glaciation.

Nocomis Girard

N. biguttatus (Kirtland) *J*

Nocomis kentuckiensis (Rafinesque) *JEC*.

Hybopsis kentuckiensis (Rafinesque) *FR 167*

RIVER CHUB, HORNYHEAD.—Found only in the recently glaciated areas. Very abundant in streams and lakes of the northeastern section. Hybridizes with *Luxilus cornutus*.

N. micropogon (Cope) *J JEC*

Has been taken only from streams of the Wabash drainage. This species may have been included with *N. biguttatus* by Forbes & Richardson under *Hybopsis kentuckiensis*.

Platygobio Gill

P. gracilis (Richardson) *J JEC FR 170*

FLATHEAD CHUB.—Has been taken only from the Ohio at Cairo and the Mississippi at Chester.

Hybopsis Agassiz

H. deliciosus (Girard) *J*

Hybopsis phenacobius Forbes *JEC*. *Notropis phenacobius* Forbes *FR 138*

Rare; streams of central Illinois.

H. volucellus (Cope) *J JEC*

Notropis blennius (Girard) *FR 137*

STRAW-COLORED MINNOW.—Distributed throughout in clear streams and creeks. Most abundant in the extreme northern part. Avoids the southern Illinoisan glaciation.

H. dorsalis (Agassiz) *J*

Hybopsis gilberti (Jordan & Meek) *JEC*.

Notropis gilberti Jordan & Meek *FR 139*

Prefers small rivers and creeks. Found in the Mississippi drainage.

H. boops Gilbert *J*

Hybopsis shumardi (Girard) *JEC*. *Notropis illecebrosus* (Girard) *FR 140*

BIG-EYED MINNOW.—Rare; closely limited to the tributaries of the Wabash in the eastern part.

H. anogenus (Forbes) *J JEC*

Notropis anogenus Forbes *FR 132*

PUGNOSE SHINER.—Rare in Illinois. Twenty-four specimens were collected in the upper Fox river at McHenry, Ill., in 1885, one individual from Fourth lake in 1892, three individuals from Pistakee lake in 1925 and 15 in 1930 from the same water.

H. heterolepis Eigenmann & Eigenmann *J*

Hybopsis cayuga (Meek) *JEC*. *Notropis cayuga* Meek *FR 133*

CAYUGA SHINER, BLACK-NOSED SHINER.—Not abundant in Illinois. Most common in creeks in the northern half of the state, although found in the northeastern glacial lakes.

H. heterodon (Cope) *J JEC*

Notropis heterodon (Cope) *FR 134*

BLACK-NOSED SHINER.—Distributed sparingly throughout, mainly in the lowland and glacial lakes in a way to indicate an avoidance of the lower Illinoisan glaciation. There is some evidence that one or two varieties of this species occur in Illinois but at the present time we are not able to separate them geographically or taxonomically.

H. nux richardsoni Hubbs & Greene *J JEC*

This form was found by Forbes and Richardson but the species had not been named at the time of their final report. It is closely related to *H. heterodon*. Taken in the lowland streams of the Wabash, Ohio and Big Muddy valleys.

H. atrocaudalis (Evermann) *J JEC*

Notropis cayuga atrocaudalis Evermann *FR* 134

Ten collections from the Illinois and adjacent waters near Meredosia, and one from the main river at Havana. Found in small numbers in the Kaskaskia and the streams of Champaign county.

H. hudsonius (DeWitt Clinton) *J*

Hudsonius hudsonius (DeWitt Clinton) *JEC*.
Notropis hudsonius (DeWitt Clinton) *FR* 141

SPOT-TAILED MINNOW.—Very abundant though limited to the Mississippi and Lake Michigan drainage, and occurring but twice south of the central part of the state. Most abundant in the larger rivers and in lakes.

H. blennius (Girard) *J*

Paranotropis jejunus (Forbes) *JEC*. *Notropis jejunus* (Forbes) *FR* 150

Distributed sparingly along the larger streams. Scarce in creeks and only moderately abundant in lowland lakes. Avoids the lower Illinoisan glaciation.

Cyprinella Girard**C. lutrensis** (Baird & Girard) *J*

Moniana lutrensis (Baird & Girard) *JEC*.
Notropis lutrensis (Baird & Girard) *FR* 143

REDFIN.—Essentially a western species, occurring only in streams of the Mississippi drainage. Prefers streams of all sizes to lakes. Forbes & Richardson (1920) states, "It is very nearly allied to the next species, *N. whipplii*, compared with which it seems to be merely a more specialized form, the two sometimes intergrading in an obscure and very puzzling way."

C. whipplii (Girard) *J*

Erogala whipplii (Girard) *JEC*. *Notropis whipplii* (Girard) *FR* 145

STEEL-COLORED MINNOW.—Extremely abundant, especially in the smaller streams of the central part. Occurs in small numbers in all other parts. Scarce in lakes and large rivers. Prefers swift water.

Luxilus Rafinesque**L. cornutus** (Mitchell) *J JEC*

Notropis cornutus (Mitchill) *FR* 147

COMMON SHINER.—Very abundant. Prefers creeks and the smaller rivers. Scarce in the southern third of the state, abundant in the rest. Hybridizes with *Nocomis biguttatus*, *Hybognathus nuchalis* and *Notropis rubrifrons*.

Notropis Rafinesque**N. photogenis** (Cope) *J JEC*

SILVER SHINER.—Recently found in bottomland lakes of the Ohio near Brookport.

N. rubrifrons (Cope) *J JEC FR* 153

ROSY-FACED SHINER.—Occurs only in the Mississippi drainage of the northern third of the state. Taken in the tributaries of the Illinois, the Rock, the Fox and the Mississippi. Prefers clear rapid water. Hybridizes with *Luxilus cornutus*.

N. atherinoides Rafinesque *J JEC FR* 151

LAKE SHINER.—Distributed throughout. Less abundant in the Illinois, the Kaskaskia and the Big Muddy than in the other stream systems. Not present in the glacial lakes of northeastern Illinois.

N. pilsbryi Fowler *JEC FR* 149

This species is a hybrid between *Luxilus cornutus* and *Notropis rubrifrons*. Taken only in the east fork of the Mazon river near Gardner, and from the Sangamon in Champaign county.

Lythrurus Jordan**L. umbratilis cyanocephalus** (Copeland) *J*

Lythrurus umbratilis (Girard) *JEC*. *Lythrurus atripes* Jordan *JEC*. *Notropis umbratilis atripes* (Jordan) *FR* 154

BLACKFIN.—Distributed throughout, being several times more numerous in the eastern half than in the western. Most

abundant in the Big Muddy, the tributaries of the Wabash and the small rivers and creeks of extreme southern Illinois. Jordan (1929) described this species as *Lythrurus atripes* from collections taken in streams of Union and Johnson counties.

Ericymba Cope

E. buccata Cope *J JEC FR 156*

SILVER-MOUTH MINNOW.—Headwaters of the minor tributaries of the Wabash and upper course of the Kaskaskia. Also in the tributaries of the Iroquois and the upper Sangamon.

Phenacobius Cope

P. mirabilis (Girard) *J JEC FR 158*

SUCKER-MOUTH MINNOW.—Most abundant in creeks. Occurs in all of our river basins but is not present in the upland glacial lakes. Prefers swift water and sandy bottom.

Ceraticthys Baird & Girard

C. vigilax Baird & Girard *J JEC*

Cliola vigilax (Baird & Girard) *FR 128*

BULLHEAD MINNOW.—Common throughout. Most abundant in the Kaskaskia and Wabash basins. Prefers swifter streams with clean bottom.

Hyborhynchus (Agassiz)

H. notatus (Rafinesque) *J JEC*

Pimephales notatus (Rafinesque) *FR 119*

BLUNT-NOSED MINNOW.—The most abundant and widely distributed minnow in Illinois. Very abundant in the lower Illinoisan glaciation, slightly less so in the waters of the northeastern part of the state.

Pimephales Rafinesque

P. promelas Rafinesque *J JEC FR 117*

BLACKHEAD MINNOW, FATHEAD.—Found in tributaries of all the stream systems in the northern and western three fourths of the state. Most abundant in creeks, the smaller rivers and ponds.

Hybognathus Agassiz

H. nuchalis Agassiz *J JEC FR 114*

SILVERY MINNOW.—Generally distributed throughout, occurring in many stream systems but most abundantly in southern Illinois. Hybridizes with *Luxilus cornutus*.

Dionda Girard

D. nubila (Forbes) *J JEC*

Hybognathus nubila (Forbes) *FR 116*

Rare; taken only in the northern part—Rock and Fox rivers.

Campostoma Agassiz

C. anomalum (Rafinesque) *J JEC FR 110*

DOUGHBELLY, GREASER CHUB, STONE-ROLLER.—Found in all creeks, where it is abundant, in the smaller rivers and occasionally in the larger rivers and lakes. Not found in streams of the lower Illinoisan glaciation.

AMEIURIDAE

Ictalurus Rafinesque

I. furcatus (Cuvier & Valenciennes) *J JEC FR 178*

BLUE CAT, FULTON CAT.—Common in the Mississippi and Ohio rivers and for a distance up their larger tributaries.

I. anguilla Evermann & Kendall *J JEC FR 179*

EEL CAT, WILLOW CAT.—Common. Found with *I. punctatus* and *Opladelus olivaris*, but in smaller numbers throughout the range.

I. punctatus (Rafinesque) *J JEC FR 180*

CHANNEL CAT, FIDDLER, SILVER CAT.—The most abundant of our true catfishes. It occurs in all river basins, sloughs and lakes. Four specimens taken in the Rock river at Rockford and Sterling in recent years seem to be hybrids between *Ictalurus punctatus* and *Opladelus olivaris*.

Villarius Rutter

V. lacustris (Walbaum) *J*

Haustor lacustris (Walbaum) *JEC. Ameiurus lacustris* (Walbaum) *FR 184*

CATFISH OF THE LAKES, NORTHERN CATFISH.—Reported as common in Lake Michigan.

Ameiurus Rafinesque

A. natalis (Le Sueur) *J JEC FR 187*

YELLOW BULLHEAD, YELLOW CAT.—Abundant throughout, except in the extreme northwestern part of the state. Most common in creeks and lowland lakes but found in all river basins, including the Michigan drainage area and the north-eastern glacial lakes.

A. nebulosus (Le Sueur) *J JEC FR 187*

SPECKLED BULLHEAD, BROWN BULLHEAD.—Distributed throughout in lakes and large sluggish rivers, except in the extreme northwestern part of the state and within the lower Illinoisan glaciation. The least abundant of our bullheads.

A. melas (Rafinesque) *J JEC FR 190*

BLACK BULLHEAD.—Distributed throughout, very abundant in the smaller streams. Least abundant in the streams of the Lake Michigan drainage and most abundant in the creeks of the Mississippi bluffs and in the valleys of the Wabash and Kaskaskia rivers. The most abundant of our bullheads.

Opladelus Rafinesque

O. olivaris (Rafinesque) *J JEC*

Leptops olivaris (Rafinesque) *FR 193*

MUD CAT, FLATHEAD CAT, GOUJON, YELLOW CAT.—Common in the Illinois, Mississippi and Ohio, and also found in the Rock and Wabash rivers. Taken in smaller numbers from the Spoon, Green, Little Wabash, Sangamon and Kaskaskia rivers and from Crooked creek.

Noturus Rafinesque

N. flavus Rafinesque *J JEC FR 194*

STONECAT.—Common and widely distributed in the larger creeks and smaller rivers of the northern half of the state, but has never been taken south of Douglas county. Prefers swift current and a rock and gravel bottom.

Rabida Jordan

R. exilis (Nelson) *J JEC*

Schilbeodes exilis (Nelson) *FR 199*

SLENDER STONECAT.—Rare; found in

the Illinois river, in the Pecatonica at Freeport, in the Du Page in Will county, in Honey creek in Henderson county, in the Sangamon in Champaign county, and in two creeks of Union county in extreme southern Illinois.

R. miurus (Jordan) *J JEC*

Schilbeodes miurus (Jordan) *FR 200*

BRINDLED STONECAT.—Confined principally to tributaries of the Wabash and Ohio. Although common, it has a spotty distribution in streams, preferring a gravel bottom and swift current. It is occasionally found in the extreme headwaters of the Kaskaskia.

Schilbeodes Bleeker

S. gyrinus (Mitchill) *J JEC FR 197*

TADPOLE CAT, MAD TOM.—Distributed throughout in larger rivers, creeks, upland and lowland lakes. Prefers still and muddy water. Enters the lower Illinoisan glaciation. This species is most abundant south and east in branches of the Kaskaskia and Wabash rivers.

S. nocturnus (Jordan & Gilbert) *J FR 198*

Rabida nocturna (Jordan & Gilbert) *JEC*

FRECKLED STONECAT.—Rare; found in creeks near Havana and Lincoln, in tributaries of the Kaskaskia in Clinton and Shelby counties, and in Camp creek in Henderson county.

UMBRIDAE**Umbra** (Krämer) Müller

U. limi (Kirtland) *J JEC FR 203*

MUD MINNOW, MUDDFISH.—Occurs almost entirely in ponds, lakes and ditches in the extreme northern and southern parts. Occasionally taken at Havana and Meredosia on the Illinois river.

ESOCIDAE**Esox** (Artedi) Linnaeus

E. vermiculatus Le Sueur *J JEC FR 206*

GRASS PIKE, LITTLE PICKEREL.—Dis-

tributed throughout, most abundantly in the southern part. Most common in creeks, but also found in ponds and the smaller rivers. Prefers quiet and muddy waters.

E. lucius Linnaeus *J FR 207*

COMMON PIKE, PICKEREL, GREAT NORTHERN PIKE.—Abundant in the headwaters of the Kankakee and the glacial lakes of the northeastern part. Occasionally taken in the clearer sloughs and lakes of the Illinois, Rock and Green rivers. This may prove to be *Esox estor* Le Sueur, an American form as yet not clearly separated from *Esox lucius* Linnaeus of Europe, as is stated in Jordan, Evermann & Clark (1930).

E. masquinongy Mitchill *J JEC FR 209*

MUSKELLUNGE.—Reported in earlier years from lakes in the northeastern part. One was taken from Fox lake by a SURVEY field party in 1930.

CYPRINODONTIDAE

Fundulus Lacépède

F. diaphanus menona (Jordan & Copeland) *J FR 211*

Zygionectes diaphanus menona (Jordan & Copeland) *JEC*

MENONA TOP MINNOW, MENONA KILLIFISH.—A northern and middle western species in the United States. Has been taken here less than 50 times, all in the northern half of the state. Found in the headwaters of the Fox, Des Plaines and Rock rivers, in pools near Bloomington and in the Calumet ponds. Prefers clear water and sand bottom.

Zygionectes Agassiz

Z. dispar Agassiz *J JEC*

Fundulus dispar Agassiz *FR 212*

BLACKCHEEK TOP MINNOW.—Occurs throughout in bottomland lakes of the larger rivers and in creeks. Abundant in the upland lakes of northeastern Illinois. Most abundant in lakes and sloughs.

Z. notatus (Rafinesque) *J JEC*

Fundulus notatus (Rafinesque) *FR 213*

TOP MINNOW, TOPWATER.—Very abundant throughout in all types of waters. Most abundant in the smaller streams and headwaters of southern and eastern parts.

POECILIIDAE

Gambusia Poey

G. patruelis (Baird & Girard) *J JEC*

Gambusia affinis (Baird & Girard) *FR 215*

MOSQUITO FISH, VIVIPAROUS TOP MINNOW.—Fairly common in extreme southern Illinois. It has been taken also from Quincy, Meredosia, Pekin and in the Fox river basin. Several specimens taken from Horseshoe lake, July 5, 1933, contained embryos with prominent eye spots. Females collected August 15 contained young apparently ready for extrusion. Prefers ditches, marshes and lagoons.

AMBLIOPSIDAE

Forbesella Jordan & Evermann

"This genus contains transitional species connecting *Chologaster* with *Typhlichthys*," Jordan (1929).

F. papillifera (Forbes) *J JEC*

Chologaster papilliferus Forbes *FR 218*

SPRING CAVE FISH.—Cave springs, Union and Pope counties.

PERCOPSIDAE

Percopsis Agassiz

P. omiscomaycus (Walbaum) *J JEC*

Percopsis guttatus Agassiz *FR 225*

TROUT PERCH.—Abundant in bottomland lakes along the Illinois river from Meredosia to Hennepin. Also from a small stream near Lincoln, Logan county, and once from Lake Michigan off Chicago.

APHREDODERIDAE

Aphredoderus Le Sueur

A. sayanus (Gilliams) *J JEC FR 229*

PIRATE PERCH.—In muddy pools and streams throughout the state, most com-

mon southward. Prefers muddy bottom and little or no current.

GASTEROSTEIDAE

Pungitius Coste

P. pungitius (Linnaeus) *J JEC*

Pygosteus pungitius (Linnaeus) *FR 224*

NINE-SPINE STICKLEBACK.—Taken but once, from the lower Calumet river and from the adjacent part of Lake Michigan.

Eucalia Jordan

E. inconstans (Kirtland) *J JEC FR 222*

BROOK STICKLEBACK.—Confined to the lakes of northeastern Illinois, the Calumet river at South Chicago, tributaries of the Rock and Fox rivers, and creeks in La Salle county. Prefers clear cool brooks. Associated with water cress.

ATHERINIDAE

Labidesthes Cope

L. sicculus (Cope) *J JEC FR 227*

BROOK SILVERSIDE.—Distributed throughout the northern, central and eastern parts, but not taken from the Big Muddy, the Saline and other waters of extreme southern Illinois. Prefers clear streams and lakes.

CENTRARCHIDAE

Huro Cuvier

H. salmoides (Lacépède) *J*

Huro floridana (Le Sueur) *JEC. Micropterus salmoides* (Lacépède) *FR 267*

LARGE-MOUTH BLACK BASS.—Equally distributed throughout, passing freely into the lower Illinoisan glaciation. Most common in the larger and more sluggish rivers, upland and lowland lakes.

Micropterus Lacépède

M. dolomieu Lacépède *J JEC FR 263*

SMALL-MOUTH BLACK BASS.—A northern fish, avoiding the lower Illinoisan glaciation. Most abundant in the smaller rivers and about half as abundant in creeks. Prefers clear swift water.

M. pseudaplites Hubbs *J JEC*

KENTUCKY BASS, SOUTHERN SMALL-MOUTH BLACK BASS.—Two specimens taken April 16, 1935, from Grand Pierre creek near Rosiclaire and one from the Ohio river at Shawneetown. General distribution is southeastern United States from western West Virginia northward to southern Ohio, westward to Kansas and central Texas.

Apomotis Rafinesque

A. cyanellus ((Rafinesque) *J JEC*

Lepomis cyanellus Rafinesque *FR 248*

GREEN SUNFISH, BLUE-SPOTTED SUNFISH.—Common throughout. Most abundant in creeks, the smaller rivers and ponds. Hybridizes with *Eupomotis gibbosus*, *Allotis humilis*, *Helioperca incisor*, *Xenotis megalotis* and *Chaenobryttus gulosus*.

A. ischyryus (Jordan & Nelson) *JEC*

Lepomis ischyryus (Jordan & Nelson) *FR 250*

BIG-NOSED SUNFISH.—Rare; not known outside of Illinois. Several specimens have been taken from the Illinois river at Meredosia. Proved by Hubbs (1932) and recent SURVEY experiments to be a hybrid between *Apomotis cyanellus* and *Helioperca incisor*.

A. euryorus (McKay) *JEC*

Lepomis euryorus McKay *FR 252*

Very rare. Has been taken only from Crooked creek near La Harpe, in Hancock county. Hubbs (1932) has proved by experimental breeding that this form is the hybrid *Apomotis cyanellus* × *Eupomotis gibbosus*.

Lethogrammus Hubbs

L. symmetricus (Forbes) *J*

Apomotis symmetricus (Forbes) *JEC. Lepomis symmetricus* Forbes *FR 251*

Rare; found in lakes and streams of southern Illinois. Also taken twice from the Illinois river at Pekin.

Sclerotis Hubbs

S. miniatus (Jordan) *J JEC*

Lepomis miniatus Jordan FR 253

OLD-FASHIONED SUNFISH, RED PERCH.
—Formerly common, now rare; taken occasionally from bottomland lakes and ponds of the Illinois river.

Allotis Hubbs

A. humilis (Girard) J JEC

Lepomis humilis (Girard) FR 255

ORANGE-SPOTTED SUNFISH.—Distributed throughout, most abundant in creeks and the smaller rivers. Rare or absent in extreme northern Illinois. Hybridizes with *Apomotis cyanellus*, *Helioperca incisor* and *Xenotis megalotis*. In Lake Senachwine and in Crystal lake in Urbana, it shows intergrades of many sorts with *Eupomotis gibbosus*, as if some hybrids between these species at these points had proved fertile and produced other segregates.

Xenotis Jordan

X. megalotis (Rafinesque) J JEC

Lepomis megalotis (Rafinesque) FR 254

LONG-EARED SUNFISH. — Extremely abundant in the smaller streams of the southern and eastern parts, comparatively scarce in the remainder of the state. Hybridizes with *Eupomotis gibbosus*, *Helioperca incisor*, *Apomotis cyanellus* and *Allotis humilis*.

X. megalotis peltastes (Cope) J

Lepomis megalotis peltastes Cope FR 254

DWARF LONG-EARED SUNFISH. — A dwarf race of northern Illinois. Has been taken only in the clear swift water of the Fox from Ottawa to the Fox lakes, in the Du Page at Naperville, in the Vermilion at Pontiac and Fairbury, in a small creek in Du Page county and in Indian creek, La Salle county.

Helioperca Jordan

H. incisor (Cuvier & Valenciennes) J JEC

Lepomis pallidus (Mitchill) FR 257

BLUEGILL, BLUE SUNFISH.—Principal sunfish of the state. Occurs throughout but most abundant in the larger streams and their principal tributaries. Also com-

mon in all lakes. Hybridizes with *Eupomotis gibbosus*, *Xenotis megalotis*, *Apomotis cyanellus*, *Chaenobryttus gulosus* and *Allotis humilis*.

Eupomotis Gill & Jordan

E. heros (Baird & Girard) J JEC FR 259

A southern species, rare in Illinois. Has been taken at a few points in the Wabash basin and in the Ohio at Brookport.

E. gibbosus (Linnaeus) J JEC FR 260

PUMKINSEED.—Very abundant in the upland lakes of Lake and McHenry counties and in lakes along the Illinois. Very scarce south of the center of the state. Essentially a pond species, and next most abundant in the smaller rivers. Produces sterile hybrids with *Helioperca incisor*, *Xenotis megalotis*, *Apomotis cyanellus* and *Chaenobryttus gulosus*. Shows fertile segregates with *Allotis humilis*.

Chaenobryttus Gill

C. gulosus (Cuvier & Valenciennes) J JEC FR 245

WARMOUTH BASS. — Distributed throughout in small numbers. Abundant in the glacial lakes of northeastern Illinois and also in the lower Illinoisan glaciation. Prefers muddy water. Hybridizes with *Eupomotis gibbosus*, *Helioperca incisor* and *Apomotis cyanellus*.

Ambloplites Rafinesque

A. rupestris (Rafinesque) J JEC FR 243

ROCK BASS, GOGGLE-EYE. — Mainly a northern species, having been taken from only five localities in southern Illinois, and not at all in the lower Illinoisan glaciation. Most abundant in rivers of medium size and in the glacial lakes.

Pomoxis Rafinesque

P. annularis Rafinesque J JEC FR 238

WHITE CRAPPIE.—Occurs in all parts, most abundantly in lakes, ponds and bayous but common also in the smaller rivers and in creeks.

P. sparoides (Lacépède) J JEC FR 240

BLACK CRAPPIE, CALICO BASS.—Found

throughout, usually with the white crap-
pie. It is slightly less common than *P.*
annularis in creeks, but more abundant in
the northeastern glacial lakes and the bot-
tomland lakes of the Illinois.

Centrarchus Cuvier & Valenciennes

C. macropterus (Lacépède) *J JEC FR 241*

ROUND SUNFISH, FLIER.—Found only
in southern Illinois from Hamilton coun-
ty southward; taken only from creeks and
sloughs tributary to the Little Wabash,
the Big Muddy, the Cache and a small
creek near Brookport. Very abundant in
Horseshoe lake.

ELASSOMIDAE

Elassoma Jordan

E. zonatum Jordan *J JEC FR 232*

PIGMY SUNFISH.—Has been taken only
six times; from Little Fox river at Phil-
lipstown, Wabash river at Wabash Sta-
tion, Drew pond in White county, Swan
pond near St. Francisville, Running lake,
and from a bluff spring in Union county.

ETHEOSTOMIDAE

Vigil Jordan

V. pellucidus (Baird) *J JEC*

Ammocrypta pellucida (Baird) *FR 301*

SAND DARTER.—Has been taken only in
the Middle Fork of the Vermilion in the
Wabash basin, lower Kaskaskia, lower
Illinois and in the Rock river.

Crystallaria Jordan & Gilbert

C. asprella (Jordan) *J JEC FR 300*

Rare; has been taken from the Rock
river at Cleveland, Erie and Milan, from
the Little Wabash at Effingham and the
Mississippi at East Dubuque. First de-
scribed from specimens taken in a rocky
creek of the Mississippi bluffs in Hancock
county.

Boleosoma De Kay

B. nigrum (Rafinesque) *J JEC FR 294*

JOHNNY DARTER.—Very abundant, dis-

tributed throughout. Most abundant in
the small streams of the Kaskaskia and
Wabash systems. Prefers creeks and
small brooks.

Vaillantia Jordan

V. camura (Forbes) *J JEC*

Boleosoma camurum Forbes *FR 298*

SNUB-NOSED DARTER.—Very abundant
in southern part. Most abundant in the
Big Muddy and Saline basins. Prefers
creeks and the smaller rivers.

Etheostoma Rafinesque

E. blennioides Rafinesque *J JEC*

Diplesion blennioides (Rafinesque) *FR 292*

GREEN-SIDED DARTER.—Has been taken
only from the smaller streams of the
Wabash system.

Imostoma Jordan

I. shumardi (Girard) *J JEC*

Cottogaster shumardi (Girard) *FR 290*

RIVER DARTER.—Not common. Occurs
wholly along the courses of the larger
streams, and has been taken from Lake
Michigan at Chicago.

Percina Haldeman

P. caprodes (Rafinesque) *J JEC FR 282*

LOG PERCH.—Distributed throughout.
Most common in lakes and medium-sized
rivers. More abundant in the northern
than in central and southern parts.

Alvordius Girard

A. evermanni (Moenkhaus) *JEC*

Hadropterus evermanni Moenkhaus *FR 284*

One specimen taken from the Illinois
river at Havana. Hubbs (1926) regards
this form as a hybrid of undetermined
parentage.

A. phoxocephalus (Nelson) *J JEC*

Hadropterus phoxocephalus (Nelson) *FR 285*

SHARP-NOSED DARTER.—Occurs
throughout except in the northern glacial
lakes. Most abundant in the smaller
streams.

A. maculatus Girard *J JEC*

Hadropterus aspro (Cope & Jordan) *FR 286*

BLACK-SIDED DARTER.—Occurs

throughout except in the northern glacial lakes. Common in the smaller rivers and creeks, rare in the larger rivers.

A. ouachitae (Jordan & Gilbert) *J JEC*
Hadropterus ouachitae (Jordan & Gilbert)
FR 288

One specimen taken from the Wabash river at New Harmony, Indiana, in 1909.

Serraria Gilbert

S. sciera (Swain) *J JEC*
Hadropterus scierus Swain *FR 289*

Two specimens taken from the Embarrass river near Charleston.

Ericosma Jordan

E. evides (Jordan & Copeland) *J JEC*
Hadropterus evides (Jordan & Copeland)
FR 288

BARRED DARTER.—One specimen taken from the Rock river in 1877. Several specimens taken from the same river at Rock Island in 1927 and at Sterling in 1932. One specimen taken from the Kaskaskia in 1930.

Nanostoma Putnam

N. zonale (Cope) *J JEC*
Etheostoma zonale (Cope) *FR 304*

BANDED DARTER.—Limited to the northern half of the state except for a single collection from the Wabash. Prefers the smaller rivers to creeks or large rivers.

Nothonotus Agassiz

N. camurus (Cope) *J JEC*
Etheostoma camurum (Cope) *FR 306*

BLUE-BREASTED DARTER.—Has been taken several times from the Salt Fork and Middle Fork of the Vermilion river. Reported from Peoria, from Union county and the Saline and lower Wabash basins.

Oligocephalus Girard

O. jessiae (Jordan & Brayton) *J JEC*
Etheostoma jessiae (Jordan & Brayton) *FR 307*

MUD DARTER.—Abundant. Prefers large streams and lowland lakes to small rivers and creeks. Not found in the up-

land glacial lakes. Three times as abundant in central and nearly twice as abundant in southern, as in northern Illinois.

O. coeruleus (Storer) *J JEC*
Etheostoma coeruleum Storer *FR 309*

RAINBOW DARTER.—Prefers creeks and smaller rivers having swift water and a clean bottom. More abundant in northern Illinois than is *O. jessiae*. Avoids the lower Illinoisan glaciation.

O. obeyensis (Kirsch) *J*
Nivicola obeyense (Kirsch) *JEC. Etheostoma obeyense* Kirsch *FR 311*

Rare; has been taken only in four collections, all from rocky and gravelly creeks in Pope and Hardin counties.

O. exilis (Girard) *J*
Oligocephalus iowae (Jordan & Meek) *JEC. Etheostoma iowae* Jordan & Meek *FR 306*

Abundant in northern Illinois in Pistakee lake, Wolf lake, Senachwine lake, Rock river, Green river, Pecunsagan creek, in the Illinois river at Ottawa and Dutchman's creek in Johnson county.

Claricola Jordan & Evermann

C. squamiceps (Jordan) *J JEC*
Etheostoma squamiceps Jordan *FR 312*

Has been taken only in southern Illinois south of the Saline river, except for one collection from Robinson creek, a branch of the Kaskaskia in Shelby county, and a collection from the Little Wabash river near Carmi in White county. Prefers swift water and gravel bottom.

Catonotus Agassiz

C. flabellaris (Rafinesque) *J JEC*
Etheostoma flabellare Rafinesque *FR 313*

FAN-TAILED DARTER.—Prefers the smaller streams. Has been taken only once within the lower Illinoisan glaciation. Most abundant in the northern third of the state, fairly abundant in the central third.

Hololepis Agassiz

H. fusiformis (Girard) *J*
Boleichthys fusiformis (Girard) *JEC FR 315*

FUSIFORM DARTER, BROWN-SIDED DART-

ER.—Most abundant in the creeks and smaller rivers. Found in the upland lakes of Lake and McHenry counties and abundant in the southeastern part of the state. Prefers sluggish water and mud bottom.

Microperca Putnam

M. punctulata Putnam *J JEC FR 317*

LEAST DARTER.—Not present in the central part but abundant in the upland lakes of northeastern Illinois. Has been taken from Skillet Fork in Wayne county and from Drury creek in Union county.

PERCIDAE

Perca (Artedi) Linnaeus

P. flavescens (Mitchill) *J JEC FR 276*

YELLOW PERCH, RINGED PERCH.—Common in the upland lakes of the northeastern part and in the Illinois and Mississippi rivers as far south as Meredosia. Has never been taken in the Wabash or Kaskaskia systems or from streams in southern Illinois.

Stizostedion Rafinesque

S. vitreum (Mitchill) *J JEC FR 272*

WALL-EYED PIKE, WALLEYE, JACK SALMON.—Abundant in the swifter waters of the Rock and Kankakee rivers. Smaller numbers in the Wabash, Mississippi, Fox and Illinois rivers.

Cynoperca Gill & Jordan

C. canadensis grisea (De Kay) *J*

Cynoperca grisea (De Kay) *JEC. Stizostedion canadense griseum* (De Kay) *FR 274*

GRAY PIKE, SAUGER, SAND PIKE.—Has been taken mainly from the Mississippi and Illinois and sparingly from the Rock, Wabash and Kaskaskia. Most common in the Ohio. In this state, *C. grisea* probably grades into *C. canadense*.

MORONIDAE

Lepibema Rafinesque

L. chrysops (Rafinesque) *J JEC*

Roccus chrysops (Rafinesque) *FR 319*

WHITE BASS.—Larger rivers and lakes. Most abundant in the Fox lakes and the Mississippi, Illinois and Ohio rivers.

Chrysoperca Fowler

C. interrupta (Gill) *J JEC*

Morone interrupta Gill *FR 321*

YELLOW BASS.—Prefers the large rivers and adjacent lakes. Most abundant in central Illinois.

SCIAENIDAE

Aplodinotus Rafinesque

A. grunniens (Rafinesque) *J JEC FR 323*

SHEEPSHEAD, FRESH-WATER DRUM, WHITE PERCH.—Abundant. Distributed throughout, commonest in central part.

COTTIDAE

Cottus (Artedi) Linnaeus

C. bairdii Girard *J*

Cottus ictalops (Rafinesque) *JEC FR 326*

MILLER'S THUMB, COMMON SCULPIN.—Has been taken only in northern and southern Illinois: in McHenry county, from tributaries of the Rock, from the Du Page river near Joliet, from rocky spring branches in Union county and from springs in Calhoun and Jersey counties.

C. ricei (Nelson) *J JEC FR 327*

One specimen taken at a depth of 600 feet from Lake Michigan, in Grand Traverse bay off Old Mission, Michigan.

C. cognatus Richardson *J*

Cottus franklini Agassiz *JEC. Uranidea kumleini* Hoy *FR 328*

EASTERN MILLER'S THUMB.—Three specimens taken in deep water from Lake Michigan, in Grand Traverse bay off Old Mission, Michigan.

GADIDAE

Lota (Cuvier) Oken

L. maculosa Le Sueur *J JEC FR 331*

LAWYER, BURBOT, LING.—Lake Michigan. Has also been taken from the Illinois at Peoria, Havana, Meredosia and

Naples, from the Rock at Milan and from the Mississippi at Rock Island.

NOTE

Melanotaenia Gill

M. nigrans Richardson

AUSTRALIAN RAINBOW FISH.—Three specimens were collected in July 1930 by Mr. Fred G. Orsinger of the John G. Shedd Aquarium, Chicago, Dr. Wilbur Luce of the University of Illinois and Dr. Thompson of the ILLINOIS STATE NATURAL HISTORY SURVEY. They were taken in a minnow seine, near the edge of a sand bar in the Mississippi river, out from the Southern Illinois Penitentiary. They were taken alive to the Shedd Aquarium, where they were identified by Dr. Carl Hubbs of the University of Michigan. It is supposed that they may have escaped from some tropical fish establishment in St. Louis, some 40 miles upstream.

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APPENDIX

HYBRIDIZATION AND RACIAL DIFFERENTIATION
AMONG ILLINOIS FISHES¹

A list of the different kinds of Illinois fishes would be incomplete without mention of the hybrids which result from crosses between certain species.

Occurrence of Hybrids

Within certain groups of fishes and in certain localities, hybrids occur in frequencies as high as one in ten, or as low as one in several thousand. The greater number and variety of hybrids among these fishes, as compared with other groups of animals, may be a reflection of the breeding habit of these fishes, whereby the sperm of the male is set free in the water to be carried over wide areas while still alive and capable of fertilizing an egg. It seems somewhat more probable that in these fishes the devices for species recognition, or "consciousness of kind," are not so effective nor so rigidly fixed as among other animals. In this connection it may be mentioned that the groups of fishes which commonly produce natural hybrids are kinds (minnows, sunfishes and darters) which exhibit striking differences in the appearance of the two sexes. Those natural hybrids which have been studied in greatest detail are sterile, grow more rapidly than do the parent species, and show an excess of males. Two apparent exceptions to the rule of sterility will be mentioned later.

Experimental Confirmation

The bulk of our knowledge of natural hybrids among native fresh-water fishes has been contributed in recent years by Doctor Carl L. Hubbs. He has produced certain hybrid combinations of sunfishes in aquaria. Doctor Wilbur M. Luce during the last three seasons has developed a method for stripping and fertilizing eggs from sunfishes and has been able to rear the hybrid young in aquaria. Two of the

sunfishes listed as ordinary species in Forbes & Richardson (1920) have now been produced experimentally by crossing other native sunfishes. At the present time almost all of the hybrid combinations of the following six species of Illinois sunfishes have been found in Illinois waters: *Apomotis cyanellus*, *Allotis humilis*, *Xenotitis megalotis*, *Helioperca incisor*, *Eupomotis gibbosus* and *Chaenobryttus gulosus*.

The recognition of hybrids among these sunfishes is facilitated by the striking and distinctive color patterns of these species, certain characteristic features of both parents appearing in the hybrid as if the color patterns were superimposed. Hybrids between the pumpkinseed and the bluegill show two shapes of body as though they were reciprocal hybrids analogous to the mule and the hinny.

Other Common Hybrids

It is now reasonably certain that many minnows, previously regarded as anomalous and unclassifiable, are in reality species hybrids among various *Cyprinidae*. In Illinois, hybrids of the common shiner, *Luxilus cornutus*, with certain nest-building minnows (as pointed out by Doctor Hubbs), are especially common, presumably because of the fact that *Luxilus* habitually deposits its eggs in the nests of these other minnows. Hybrids within the group of darters are also believed to be rather common. A few readily recognized hybrids between goldfish and the European carp have been found in Illinois waters. Three or four catfishes have been taken in Rock river which appear to be hybrids between the channel cat, *Ictalurus punctatus*, and the flathead cat, *Opladelus olivaris*, both of which spawn in holes, hollow logs, etc. While it has not been proved that the so-called "mongrel" buffalo, *Ictiobus urus*, is really a hybrid

¹By David H. Thompson.



Fig. 3.—Raising SURVEY hoop net along the east bank of the Illinois river below Havana.

between the other two native species, there is a considerable body of circumstantial evidence to indicate that such is the case. Some of the difficulties of identification in the genus *Carpionodes* and in the genus *Moxostoma* may be attributed to occasional hybridization within these genera.

Known Fertile Hybrids

In all of the above-named hybrids, whether proved or presumptive, the evidence indicates that they are in reality "mules" and incapable of propagation. In Illinois we have found two apparent exceptions to this rule. One of these has to do with the intergradation of *Cyprinella lutrensis* and *Cyprinella whipplii* in the region about the mouth of the Sangamon river near Chandlerville and Beardstown. At this point we not only find typical *lutrensis* and typical *whiplii* but also all possible combinations of the characteristics which are used to separate these two species.

Intergradations of this sort have also been found between the orange-spotted sunfish and the pumpkinseed sunfish in two localities—Senachwine lake near Henry and Crystal lake in Urbana. It seems certain that some hybrids between these two species have been fertile. Segregation and recombination of the characteristics of these two species have not been found in other waters of the state where they both occur. A rather detailed

study of the segregates of this pair of species in Lake Senachwine suggests that the hybrids between these two species have not bred *inter se* but have back-crossed to the orange-spotted sunfish.

Difference and Distance

A few years ago while making a detailed study of the fishes of the small streams which drain Champaign county, it was found that the fan-tailed darters, *Catnotus flabellaris*, of the streams draining into the Wabash had a consistently lower average number of spines in the dorsal fin than did those from streams draining into the Mississippi. It was also noticed that the orange-spotted sunfish, *Allotis humilis*, of the Sangamon river, which drains to the west, had a consistently steeper profile than did the same species in the Salt Fork, which drains to the east.

A study of the average dorsal spine and ray numbers of the Johnny darter, *Boleosoma nigrum*, collected from the various streams of Champaign county showed that the difference between the mean spine or ray numbers of any two populations increased with the water distance separating

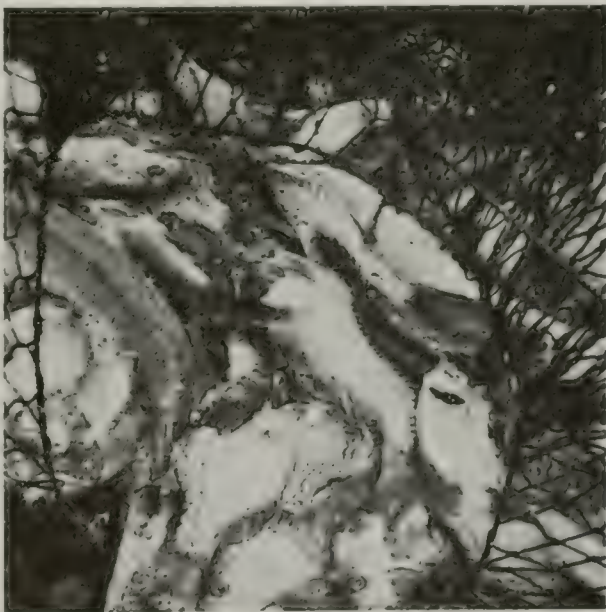


Fig. 4.—Opening the tail compartment of a SURVEY hoop net, showing a catch of black crappies, carp and other fishes from the Illinois river.

these populations. The Johnny darter is well suited for such a study, since it is abundant, cosmopolitan in its range and sedentary in habit. The sedentary habit is to be emphasized because it appears that measurable differences between the mean spine or ray numbers of populations from different stream systems occur only among the more sedentary kinds. When such differences were sought among actively migrating kinds such as the suckers, they were not found. In brief, we may conclude that some kinds of fishes move so slowly that a measurable degree of evolution takes place while they are traveling from one stream to another.

Fin Phylogeny

A later and still more detailed study of the Johnny darters from all parts of Illinois, and using counts of the spines and rays of all of the fins, has substantiated the conclusion that the difference between the mean spine or ray numbers of two populations increases with increasing water distance separating these populations. This evidence indicates that these observed differences in average spine or ray numbers result, for the most part, from hereditary differences, and not from differences in the environment in which the various populations developed. The difference between the mean spine or ray numbers of any two populations is nearly proportional to the logarithm of water distance separating them.

It should be understood that water distance, as used here, implies water distance between different parts of the Mississippi system where there have been no barriers to the free movement of fishes until recent years. When the spine and ray numbers of the Johnny darter are compared with the spine and ray numbers of other subspecies of the Johnny darter, such as

Boleosoma nigrum olmstedii, (found in streams draining into the Atlantic from Quebec to Maryland) it is found that this difference is about twice as great as the average difference found between points within the Mississippi system separated by 3,000 miles of water.

Similarly, the amount of difference found between *Boleosoma nigrum* and another closely related Illinois species, *Vaillantia camura*, is about twice as great as the difference found between subspecies of the Johnny darter.

Other Taxonomic Differences

Not only are there consistent racial differences in the number of spines and rays of the Johnny darter and other sedentary fishes, but we also find consistent differences between different stream systems involving other taxonomic characteristics which are commonly used by ichthyologists to separate species, such as, for example, number of scales in the lateral line, number of scales bearing pores, number of rows of scales, color pattern, degree of scalation of body, cheek, nape and breast, the body contour and point of insertion of fins. Spine and ray numbers in the fins have been used in these studies merely because they seem to show nonadaptive variations, and because they may be easily and accurately treated in a quantitative manner. These considerations suggest that the degree of difference between any two fish populations forms a continuous series from the most insignificant racial differences up to the largest family differences.

Some of the evolutionary and genetic aspects of these racial differences in fishes as related to the nature of fish species have been discussed in two short papers published in the Transactions of the Illinois State Academy of Science (Thompson 1931, 1934).

INDEX TO FAMILIES, GENERA AND SPECIES

The index refers only to the mention or placement of names in the classified list, pp. 475-91. Synonymy is indicated by italic type. Family names are in capitals.

A

Abramis crysoleucas 480
Acipenser fulvescens 475
 rubicundus 475
 ACIPENSERIDAE 475
affinis, *Gambusia* 485
 albus, *Parascaphirhynchus* 475
 alligator gar 477
Allotis humilis 487
Alosa ohioensis 477
 alosoides, *Amphiodon* 477
 Hiodon 477
 alpenae, *Leucichthys* 478
Alvordius evermanni 488
 maculatus 488
 ouachitae 489
 phoxocephalus 488
Ambloplites rupestris 487
amblops, *Hybopsis* 481
 AMBLYOPSIDAE 485
 AMEIURIDAE 483
Ameiurus lacustris 483
 melas 484
 natalis 484
 nebulosus 484
 American eel 478
Amia calva 477
 AMIIDAE 477
Ammocrypta pellucida 488
Amphiodon alosoides 477
Anguilla bostoniensis 478
 chrysypa 478
 rostrata 478
 anguilla, *Ictalurus* 483
 ANGUILLIDAE 478
anisurum, *Moxostoma* 479
annularis, *Pomoxis* 487
anogenus, *Hybopsis* 481
 Notropis 481
 anomalum, *Campostoma* 483
 APHREDODERIDAE 485
Aphredoderus sayanus 485
Aplodinotus grunniens 490
Apomotis cyanellus 486
 euryorus 486
 ischyrus 486
 symmetricus 486
 appendix, *Lethenteron* 475
Argyrosomus artedi 478
artedi, *Argyrosomus* 478
 Leucichthys 478
asprella, *Crystallaria* 488
aspro, *Hadropterus* 488
 ATHERINIDAE 486
atherinoides, *Notropis* 482
Atractosteus spatula 477
 tristoechus 477
atripes, *Lythrurus* 482
 Notropis umbratilis 482
atrocaudalis, *Hybopsis* 482
 Notropis cayuga 482

atromaculatus, *Semotilus* 480
atronasus, *Rhinichthys* 480
auratus, *Carassius* 480
aureolum, *Moxostoma* 479
 Australian rainbow fish 491
 B
bairdii, *Cottus* 490
 banded darter 489
 barred darter 489
 bass, calico 487
 Kentucky 486
 large-mouth black 486
 rock 487
 small-mouth black 486
 southern small-mouth
 black 486
 warmouth 487
 white 490
 yellow 490
 big-eyed chub 481
 minnow 481
 big-mouth buffalo 478
 big-nosed sunfish 486
 big-toothed red horse 480
biguttatus, *Nocomis* 481
 billy gar 477
 black bass, large-mouth 486
 small-mouth 486
 southern small-mouth 486
 bullhead 484
 crappie 487
 horse 478
 lamprey, small 475
 sucker 479
 blackcheek top minnow 485
 blackfin 478, 482
 blackhead minnow 483
 black-nosed dace 480
 shiner 481
 black-sided darter 488
blennioides, *Diplesion* 488
 Etheostoma 488
blennius, *Hybopsis* 482
 Notropis 481
 blue cat 483
 herring 477
 sunfish 487
 blue-breasted darter 489
 bluefish 478
 bluegill 487
 blue-spotted sunfish 486
 blunt-nosed minnow 483
 river carp 479
Boleichthys fusiformis 489
Boleosoma camurum 488
 nigrum 488
 boneless cat 475
 boops, *Hybopsis* 481
bostoniensis, *Anguilla* 478
 bowfin 477

bream 480
breviceps, *Moxostoma* 480
 brindled stonecat 484
 brook lamprey 475
 silverside 486
 stickleback 486
 trout, eastern 478
 brown bullhead 484
 trout, German 478
 brown-sided darter 489
bubalus, *Ictiobus* 478
buccata, *Ericymba* 483
 buffalo, big-mouth 478
 highback 479
 mongrel 478
 quillback 478
 razorback 479
 red-mouth 478
 round 478
 small-mouth 478
 bullhead, black 484
 brown 484
 minnow 483
 speckled 484
 yellow 484
 burbot 490

C

calico bass 487
calva, *Amia* 477
Campostoma anomalum 483
camura, *Vaillantia* 488
camurum, *Boleosoma* 488
 Etheostoma 489
camurus, *Nothonotus* 489
canadense, *Cynoperca* 490
 griseum, *Stizostedion* 490
canadensis grisea, *Cynoperca*
 490
caprodes, *Percina* 488
Carassius auratus 480
carinatus, *Placopharynx* 480
 carp, blunt-nosed river 479
 common river 479
 European 480
 lake 479
 silver 479
 carpio, *Carpionides* 479
 Cyprinus 480
Carpionides carpio 479
 cyprinus 479
 difformis 479
 thompsoni 479
 velifer 479
 cat, blue 483
 boneless 475
 channel 483
 eel 483
 flathead 484
 Fulton 483
 mud 484

silver 483
 spoonbill 475
 tadpole 484
 willow 483
 yellow 484
 cataractae, *Rhinichthys* 480
 catfish, northern 483
 of the lakes 483
Catonotus flabellaris 489
 CATOSTOMIDAE 478
Catostomus catostomus 479
 commersonii 479
 nigricans 479
 cave fish, spring 485
 Cayuga shiner 481
cayuga atrocaudalis, *Notropis* 482
 Hybopsis 481
 Notropis 481
 CENTRARCHIDAE 486
Centrarchus macropterus 488
 cepedianum, *Dorosoma* 477
Ceraticthys vigilax 483
Chaenobryttus gulosus 487
 channel cat 483
Chologaster papilliferus 485
Chrosomus erythrogaster 480
chrysochlorus, *Pomobolus* 477
Chrysoperca interrupta 490
 chrysops, *Lepibema* 490
 Rocca 490
chrysypa, *Anguilla* 478
 chub 478
 big-eyed 481
 creek 480
 flathead 481
 greaser 483
 river 481
 silver 481
 Storer's 481
 sucker 479
 cisco 478
 mooneye 478
Claricola squamiceps 489
Cliola vigilax 483
clupeaformis, *Coregonus* 477
 CLUPEIDAE 477
coeruleum, *Etheostoma* 489
coeruleus, *Oligocephalus* 489
cognatus, *Cottus* 490
commersonii, *Catostomus* 479
 common lake herring 478
 pike 485
 red horse 479
 river carp 479
 sculpin 490
 shiner 482
 sucker 479
 whitefish 477
 concolor, *Ichthyomyzon* 475
 COREGONIDAE 477
Coregonus clupeaformis 477
 quadrilateralis 477
 cornutus, *Luxilus* 482
 Notropis 482
 COTTIDAE 490
Cottogaster shumardi 488
Cottus bairdii 490

cognatus 490
franklini 490
ictalops 490
ricei 490
 crappie, black 487
 white 487
 creek chub 480
Cristivomer namaycush 478
crysoleucas, *Abramis* 480
 Notemigonus 480
Crystallaria asprella 488
cyanellus, *Apomotis* 486
 Lepomis 486
cycnocephalus, *Lythrurus umbratilis* 482
Cycleptus elongatus 478
Cylindrosteus platostomus 477
Cynoperca canadense 490
 canadensis grisea 490
 grisea 490
Cyprinella lutrensis 482
 whippilii 482
cyprinella, *Ictiobus* 478
 Megastomatobus 478
 CYPRINIDAE 480
 CYPRINODONTIDAE 485
Cyprinus carpio 480
cyprinus, *Carpiodes* 479

D

dace, black-nosed 480
 horned 480
 long-nosed 480
 red-bellied 480
 darter, banded 489
 barred 489
 black-sided 488
 blue-breasted 489
 brown-sided 489
 fan-tailed 489
 fusiform 489
 green-sided 488
 Johnny 488
 least 490
 mud 489
 rainbow 489
 river 488
 sand 488
 sharp-nosed 488
 snub-nosed 488
deliciosus, *Hybopsis* 481
diaphanus menona, *Fundulus* 485
 Zygionectes 485
difformis, *Carpiodes* 479
Dionda nubila 483
Diplesion blennioides 488
dispar, *Fundulus* 485
 Zygionectes 485
dissimilis, *Erimystax* 481
 Hybopsis 481
 dogfish 477
dolomieu, *Micropterus* 486
Dorosoma cepedianum 477
 DOROSOMIDAE 477
dorsalis, *Hybopsis* 481

doughbelly 483
 drum, fresh-water 490
duquesnei, *Placopharynx* 480
 dwarf long-eared sunfish 487

E

eastern brook trout 478
 miller's thumb 490
 eel, American 478
 cat 483
 fresh-water 478
 lamper 475
Elassoma zonatum 488
 ELASSOMIDAE 488
elongatus, *Cycleptus* 478
emiliae, *Opsopoeodus* 480
Ericosma evides 489
Ericymba buccata 483
Erimystax dissimilis 481
Erimyzon oblongus 479
 sucetta 479
 oblongus 479
Erinemus hyalinus 481
 storerianus 481
Erogala whippilii 482
erythrogaster, *Chrosomus* 480
 ESOCIDAE 484
Esox estor 485
 lucius 485
 masquinongy 485
 vermiculatus 484
estor, *Esox* 485
Etheostoma blennioides 488
 camurum 489
 coeruleum 489
 flabellare 489
 iowae 489
 jessiae 489
 obeyense 489
 squamiceps 489
 zonale 489
 ETHEOSTOMIDAE 488
Eucalia inconstans 486
Eupomotis gibbosus 487
 heros 487
 European carp 480
euryorus, *Apomotis* 486
 Lepomis 486
evermanni, *Alvordius* 488
 Hadropterus 488
evides, *Ericosma* 489
 Hadropterus 489
exilis, *Oligocephalus* 489
 Rabida 484
 Schilbeodes 484
Extrarius hyostomus 480

F

fan-tailed darter 489
 fathead 483
 fiddler 483
 fine-scaled sucker 479
 fish, Australian rainbow 491
 mosquito 485
 spring cave 485
flabellare, *Etheostoma* 489

flabellaris, *Catnotus* 489
 flathead cat 484
 chub 481
 flavescens, *Perca* 490
 flavus, *Noturus* 484
 fier 488
floridana, *Huro* 486
 fontinalis, *Salvelinus* 478
 Forbesella papillifera 485
franklini, *Cottus* 490
 freckled stonecat 484
 fresh-water drum 490
 eel 478
 Fulton cat 483
 fulvescens, *Acipenser* 475
Fundulus diaphanus menona
 485
 dispar 485
 notatus 485
 furcatus, *Ictalurus* 483
 fusiform darter 489
 fusiformis, *Boleichthys* 489
 Hololepis 489

G

GADIDAE 490

gairdnerii, *Salmo* 478
Gambusia affinis 485
 patruelis 485
 gar, alligator 477
 billy 477
 long-nosed 477
 short-nosed 477

GASTEROSTEIDAE 486

gelida, *Macrhybopsis* 480
gelidus, *Macrhybopsis* 480
 German brown trout 478
gibbosus, *Eupomotis* 487
gilberti, *Hybopsis* 481
 Notropis 481
 gizzard shad 477
 goggle-eye 487
 golden shad 477
 shiner 480

goldeye 477
 goldfish 480
 goujon 484
gracilis, *Platygobio* 481
 grass pike 484
 gray pike 490
 greaser chub 483
 great northern pike 485
 green sunfish 486
 green-sided darter 488
 grindle 477
grisea, *Cynoperca* 490
 canadensis 490
 Cynoperca 490
griseum, *Stizostedion canadense*
 490
 grunniens, *Aplodinotus* 490
 gulosus, *Chaenobryttus* 487
guttatus, *Percopsis* 485
 gyrinus, *Schilbeodes* 484

H

hackleback 475

Hadropterus aspro 488
 evermanni 488
 evides 489
 ouachitae 489
 phoxocephalus 488
 scierus 489
 Hagochila lacera 480
 hammerhead 479
Haustor lacustris 483
Helioperca incisor 487
 heros, *Eupomotis* 487
 herring, blue 477
 common lake 478
 lake 478
 toothed 477
 heterodon, *Hybopsis* 481
 Notropis 481
 heterolepis, *Hybopsis* 481
 hickory shad 477
 highback buffalo 479
Hiodon alosoides 477
 tergisus 477
 HIODONTIDAE 477
 hog sucker 479
Hololepis fusiformis 489
 horned dace 480
 hornyhead 481
 horse, big-toothed red 480
 black 478
 common red 479
 short-headed red 480
 hoyi, *Leucichthys* 478
Hudsonius hudsonius 482
hudsonius, *Hybopsis* 482
 Notropis 482
 humilis, *Allotis* 487
 Lepomis 487
Huro floridana 486
 salmoides 486
 hyalinus, *Erinemus* 481
Hybognathus nubila 483
 nuchalis 483
Hybopsis amblops 481
 anogenus 481
 atrocaudalis 482
 blennius 482
 boops 481
 cayuga 481
 deliciosus 481
 dissimilis 481
 dorsalis 481
 gilberti 481
 heterodon 481
 heterolepis 481
 hudsonius 482
 hyostomus 480
 kentuckiensis 481
 nux richardsoni 482
 phenacobius 481
 shumardi 481
 storerianus 481
 volucellus 481
Hyborhynchus notatus 483
hyostoma, *Macrhybopsis* 480
hyostomus, *Extrarius* 480
 Hybopsis 480
Hypentelium nigricans 479

I

Ichthyomyzon concolor 475
ictalops, *Cottus* 490
Ictalurus anguilla 483
 furcatus 483
 punctatus 483
Ictiobus bubalus 478
 cyprinella 478
 urus 478
illecebrosus, *Notropis* 481
Imostoma shumardi 488
incisor, *Helioperca* 487
inconstans, *Eucalia* 486
interrupta, *Chrysoperca* 490
 Morone 490
iowae, *Etheostoma* 489
 Oligocephalus 489
iridea, *Trutta* 478
irideus, *Salmo* 478
ischyrus, *Apomotis* 486
 Lepomis 486

J

jack salmon 490
jejunus, *Notropis* 482
 Paranotropis 482
jessiae, *Etheostoma* 489
 Oligocephalus 489
johannae, *Leucichthys* 478
 Johnny darter 488

K

kentuckiensis, *Hybopsis* 481
 Nocomis 481
 Kentucky bass 486
 killifish, *Menona* 485
 kiyi, *Leucichthys* 478
kumleinii, *Uranidea* 490

L

Labidesthes sicculus 486
lacera, *Hagochila* 480
lacustris, *Ameiurus* 483
 Haustor 483
 Villarius 483
 lake carp 479
 herring 478
 shiner 482
 sturgeon 475
 trout 478
 lakes, catfish of the 483
 lamper 475
 eel 475
Lampetra wilderi 475
 lamprey 475
 brook 475
 small black 475
 landlocked salmon 478
 large-mouth black bass 486
 lawyer 490
 least darter 490
Lepibema chrysops 490
 LEPISOSTEIDAE 477
Lepisosteus osseus 477

platostomus 477
tristoechus 477
Lepomis cyanellus 486
euryorus 486
humilis 487
ischyrus 486
megalotis 487
peltastes 487
miniatus 487
pallidus 487
symmetricus 486
Leptops olivaris 484
lesueurii, *Moxostoma* 480
Lethenteron appendix 475
Lethogrammus symmetricus 486
Leucichthys alpenae 478
artedi 478
hoi 478
johannae 478
kiyi 478
nigripinnis 478
reighardi 478
zenithicus 478
limi, *Umbra* 484
ling 490
little pickerel 484
log perch 488
long-eared sunfish 487
dwarf 487
longjaw 478
long-nosed dace 480
gar 477
sturgeon 475
sucker 479
Lota maculosa 490
lucius, *Esox* 485
lutrensis, *Cyprinella* 482
Moniana 482
Notropis 482
Luxilus cornutus 482
Lythrurus atripes 482
umbratilis 482
cynocephalus 482

M

Macrhybopsis gelida 480
gelidus 480
hyostoma 480
macropterus, *Centrarchus* 488
maculatus, *Alvordius* 488
maculosa, *Lota* 490
mad Tom 484
masquinongy, *Esox* 485
megalotis, *Lepomis* 487
peltastes, *Lepomis* 487
Xenotis 487
Megastomatobus cyprinella 478
melanops, *Minytrema* 479
Melanotaenia nigrans 491
melas, *Ameiurus* 484
Menominee whitefish 477
Menona killifish 485
top minnow 485
menona, *Fundulus diaphanus* 485

Zygonectes diaphanus 485
Microperca punctulata 490
micropogon, *Nocomis* 481
Micropterus dolomieu 486
pseudaplites 486
salmoides 486
miller's thumb 490
eastern 490
miniatus *Lepomis* 487
Sclerotis 486
minnow, *big-eyed* 481
blackcheek top 485
blackhead 483
blunt-nosed 483
bullhead 483
Menona top 485
mud 484
silver-mouth 483
silvery 483
spot-tailed 482
steel-colored 482
straw-colored 481
sucker-mouth 483
top 485
viviparous top 485
Minytrema melanops 479
mirabilis, *Phenacobius* 483
Missouri sucker 478
miurus, *Rabida* 484
Schilbeodes 484
mongrel buffalo 478
Miniana lutrensis 482
mooneye 477, 478
cisco 478
northern 477
Morone interrupta 490
MORONIDAE 490
mosquito fish 485
Moxostoma anisurum 479
aureolum 479
breviceps 480
lesueurii 480
mud cat 484
darter 489
minnow 484
mudfish 484
muskellunge 485

N

namaycush, *Cristivomer* 478
Nanostoma zonale 489
natalis, *Ameiurus* 484
nebulosus, *Ameiurus* 484
nigrans, *Melanotaenia* 491
nigricans, *Catostomus* 479
Hypentelium 479
nigripinnis, *Leucichthys* 478
nigrum, *Boleosoma* 488
nine-spine stickleback 486
Nivicola obeyense 489
Nocomis biguttatus 481
kentuckiensis 481
micropogon 481
nocturna, *Rabida* 484
nocturnus, *Schilbeodes* 484
northern catfish 483
mooneye 477
pike, *great* 485

sucker 479
notatus, *Fundulus* 485
Hyborhynchus 483
Pimephales 483
Zygonectes 485
Notemigonus crysoleucas 480
Nothonotus camurus 489
Notropis anogenus 481
atherinoides 482
blennius 481
cayuga 481
atrocaudalis 482
cornutus 482
gilberti 481
heterodon 481
hudsonius 482
illecebrosus 481
jejunus 482
lutrensis 482
phenacobius 481
photogenis 482
pilsbryi 482
rubrifrons 482
umbratilis atripes 482
whiplii 482
Noturus flavus 484
nubila, *Dionda* 483
Hybognathus 483
nuchalis, *Hybognathus* 483
nux richardsoni, *Hybopsis* 482

O

obeyense, *Etheostoma* 489
Nivicola 489
obeyensis, *Oligocephalus* 489
oblongus, *Erimyzon* 479
Erimyzon sucetta 479
ohiensis, *Alosa* 477
Ohio shad 477
old-fashioned sunfish 487
Oligocephalus coeruleus 489
exilis 489
iowae 489
jessiae 489
obeyensis 489
olivaris, *Leptops* 484
Opladelus 484
omiscomaycus, *Percopsis* 485
Opladelus olivaris 484
Opsopoeodus emiliae 480
orange-spotted sunfish 487
osseus, *Lepisosteus* 477
ouachitae, *Alvordius* 489
Hadropterus 489

P

paddlefish 475
pallidus, *Lepomis* 487
papillifera, *Forbesella* 485
papilliferus, *Chologaster* 485
Paranotropis jejunos 482
Parascaphirhynchus albus 475
patruelis, *Gambusia* 485
pellucida, *Ammocrypta* 488
pellucidus, *Vigil* 488
peltastes, *Lepomis megalotis* 487

Xenotis megalotis 487

Perca flavescens 490

perch, log 488

pirate 485

red 487

ringed 490

trout 485

white 490

yellow 490

PERCIDAЕ 490

Percina caprodes 488

PERCOPSIDAE 485

Percopsis guttatus 485

omiscomaycus 485

PETROMYZONIDAE 475

Phenacobius mirabilis 483

phenacobius, *Hybopsis* 481

Notropis 481

photogenis, *Notropis* 482

phoxocephalus, *Alvordius* 488

Hadropterus 488

pickerel 485

little 484

pigmy sunfish 488

pike, common 485

grass 484

gray 490

great northern 485

sand 490

wall-eyed 490

pilsbryi, *Notropis* 482

Pimephales notatus 483

promelas 483

pirate perch 485

Placopharynx carinatus 480

duquesnei 480

platyrhynchus, *Scaphirhynchus* 475

platostomus, *Cylindrosteus* 477

Lepisosteus 477

Platygobio gracilis 481

POECILIIDAE 485

Polyodon spathula 475

POLYDONTIDAE 475

Pomobolus chrysochlorus 477

Pomoxis annularis 487

sparoides 487

promelas, *Pimephales* 483

Prosopium quadrilaterale 477

pseudaplites, *Micropterus* 486

pugnose shiner 481

pumpkinseed 487

punctatus, *Ictalurus* 483

punctulata, *Microperca* 490

Pungitius pungitius 486

Pygosteus pungitius 486

Q

quadrilaterale, *Prosopium* 477

quadrilateralis, *Coregonus* 477

quillback 479

buffalo 478

R

rabbit-mouth sucker 480

Rabida exilis 484

miurus 484

nocturna 484

rainbow darter 489

fish, Australian 491

trout 478

razorback buffalo 479

red horse, big-toothed 480

common 479

short-headed 480

perch 487

sucker 479

red-bellied dace 480

redfin 482

red-mouth buffalo 478

reighardi, *Leucichthys* 478

Rhinichthys atronasmus 480

cataractae 480

ricei, *Cottus* 490

richardsoni, *Hybopsis nux* 482

ringed perch 490

river carp, blunt-nosed 479

common 479

chub 481

darter 488

roach 480

Roccus chrysops 490

rock bass 487

sturgeon 475

rostrata, *Anguilla* 478

rosy-faced shiner 482

round buffalo 478

sunfish 488

whitefish 477

rubicundus, *Acipenser* 475

rubrifrons, *Notropis* 482

rupestris, *Ambloplites* 487

S

salar sebago, *Salmo* 478

Salmo gairdnerii 478

irideus 478

salar sebago 478

salmoides, *Huro* 486

Micropterus 486

salmon, jack 490

landlocked 478

Sebago 478

SALMONIDAE 478

Salvelinus fontinalis 478

sand darter 488

pike 490

sauger 490

sayanus, *Aphredoderus* 485

Scaphirhynchus platyrhynchus

475

Schilbeodes exilis 484

gyrinus 484

miurus 484

nocturnus 484

SCIAENIDAE 490

sciera, *Serraria* 489

scierus, *Hadropterus* 489

Sclerotis miniatus 486

sculpin, common 490

Sebago salmon 478

sebago, *Salmo salar* 478

Semotilus atromaculatus 480

Serraria sciera 489

shad 479

gizzard 477

golden 477

hickory 477

Ohio 477

sharp-nosed darter 488

sheepshead 490

shiner, black-nosed 481

Cayuga 481

common 482

golden 480

lake 482

pugnose 481

rosy-faced 482

silver 482

spotted 481

short-headed red horse 480

short-nosed gar 477

shovel-nosed sturgeon 475

shumardi, *Cottogaster* 488

Hybopsis 481

Imostoma 488

sicculus, *Labidesthes* 486

silver carp 479

cat 483

chub 481

shiner 482

silvreen 479

silver-mouth minnow 483

silverside, brook 486

silvery minnow 483

skipjack 477

slender stonecat 484

small black lamprey 475

small-mouth black bass 486

southern 486

buffalo 478

snub-nosed darter 488

southern small-mouth black

bass 486

sparoides, *Pomoxis* 487

spathula, *Polyodon* 475

spatula, *Atractosteus* 477

speckled bullhead 484

trout 478

spoonbill cat 475

spot-tailed minnow 482

spotted shiner 481

sucker 479

spring cave fish 485

squamiceps, *Claricola* 489

Etheostoma 489

steel-colored minnow 482

stickleback, brook 486

nine-spine 486

Stizostedion canadense griseum

490

vitreum 490

stonecat 484

brindled 484

freckled 484

slender 484

stoneroller 479, 483

storerianus, *Erinemus* 481

Hybopsis 481

Storer's chub 481

straw-colored minnow 481

striped sucker 479

sturgeon, lake 475
 long-nosed 475
 rock 475
 shovel-nosed 475
 white 475
 sucetta, *Erimyzon* 479
 oblongus, *Erimyzon* 479
 sucker, black 479
 chub 479
 common 479
 fine-scaled 479
 hog 479
 long-nosed 479
 Missouri 478
 northern 479
 rabbit-mouth 480
 red 479
 spotted 479
 striped 479
 sweet 479
 white-nosed 479
 sucker-mouth minnow 483
 sunfish, big-nosed 486
 blue 487
 blue-spotted 486
 dwarf long-eared 487
 green 486
 long-eared 487
 old-fashioned 487
 orange-spotted 487
 pigmy 488
 round 488
 Superior whitefish 477
 sweet sucker 479
 symmetricus, *Apomotis* 486
Lepomis 486
 Lethogrammus 486

T

tadpole cat 484
 tergisus, *Hiodon* 477
 thompsoni, *Carpiodes* 479

thumb, miller's 490
 eastern miller's 490
 Tom, mad 484
 toothed herring 477
 top minnow 485
 blackcheek 485
 Menona 485
 viviparous 485
 topwater 485
 tristoechus, *Atractosteus* 477
Lepisosteus 477
 trout, eastern brook 478
 German brown 478
 lake 478
 perch 485
 rainbow 478
 speckled 478
 Trutta iridea 478
 trutta 478

U

Umbra limi 484
 umbratilis *atripes*, *Notropis* 482
Cyanocephalus, *Lythrurus* 482
Lythrurus 482
 UMBRIDAE 484
Uranidea kumleini 490
 urus, *Ictiobus* 478

V

Vaillantia camura 488
velifer, *Carpiodes* 479
 vermiculatus, *Esox* 484
 Vigil pellucidus 488
 Vigilax, *Ceraticthys* 483
Cliola 483
 Villarius lacustris 483
 vitreum, *Stizostedion* 490
 viviparous top minnow 485
 volucellus, *Hybopsis* 481

W

walleye 490
 wall-eyed pike 490
 warmouth bass 487
 whiplii, *Cyprinella* 482
Erogala 482
Notropis 482
 white bass 490
 crappie 487
 perch 490
 sturgeon 475
 whitefish, common 477
 Menominee 477
 round 477
 Superior 477
 white-nosed sucker 479
wilderi, *Lampetra* 475
 willow cat 483

X

Xenotis megalotis 487
 peltastes 487

Y

yellow bass 490
 bullhead 484
 cat 484
 perch 490

Z

zenithicus, *Leucichthys* 478
 zonale, *Etheostoma* 489
Nanostoma 489
 zonatum, *Elassoma* 488
Zygonectes diaphanus menona 485
 dispar 485
 notatus 485

INDEX

The reader is referred to preceding indexes of families, genera and species at pages 270-79 for Dermaptera and Orthoptera, 468-71 for Plecoptera, and 495-500 for the fishes of Illinois. Inasmuch as articles I and II were printed without indexes, items pertaining to them have been gathered below under the headings "elm disease" and "fishery of the Kaskaskia river," respectively.

A

Ambraw river—see Embarrass river
Anax, facing 473, 474
Apple river 476
Australian rainbow fish 491

B

bacteria on elm 58
Big Bay creek 476
Big Muddy river 476

C

Cache river 476
canal, Illinois-Mississippi 476
chief plant inspector, requests elm disease investigation 3
cockroaches—see Orthoptera
control 269
Crooked creek 476

D

Dermaptera 150, 151
Desplaines river 476
Diseases of elm—see elm disease

E

elm disease 1-70
agars 13, 15, 32-34, 38, 40-45, 48, 50-57
Alternaria 17, 19, 20, 44, 45, 51, 52
American elm, anthracnose in 1
investigation of 1
leaf spot 1
Anthostomella 17, 19, 41, 49, 52
anthracnose in American elm 1
ascomycetous fungus 52
bacteria 58
Basisporium gallarum 54
Buisman, examines Illinois trees 1
cankers 8, 10, 11, 16, 18, 25, 41-43, 45, 46, 52
cause, thought to be elm borer 3
Cephalosporium 17, 19, 51
Ceratostomella Ulmi 2
Champaign, Illinois, *Vermicularia* in 39
chief plant inspector, requests investigation 3
combinations of fungi in isolations 19

elm disease—cont'd

Coniothyrium 17-32, 37-40, 42, 43, 49, 59, 65-67
Fuckelii 37
Ulmi 37
contamination, culture 17
control experiments 59-67
cultures 12
contamination 17
general results of tests 15-20
stock 13
Cytospora 17, 20, 52, 53
ambiens 53
Danville, Illinois, *Coniothyrium* in 21
data, recording 14
Diaporthe 46
Diplodia 17, 20, 53, 54
Ulmi 53, 54
distribution, statewide 9
Dutch elm disease, caused by *Ceratostomella Ulmi* 2
found by May in Ohio 1
not in Illinois 2
presence suspected 1
dying elms, observed prior to 1883 3
El Dara, Illinois, *Coniothyrium* in 21
elm borer, thought cause of disease 3
"elm wilt," erroneous name 1, 20
elms examined, wild 11
Endothia 13
Epicoccum 17, 19, 20, 57, 58
experiments, control 59-67
Forbes, Dr. S. A., observes dying elms prior to 1883 3
Freeman nursery, cooperates in study 2, 61
fungous parasitization, symptom of 6
fungi, ascomycetous 52
combinations of in isolations 19
culturing 12, 13
genera recognized 17
isolations 12, 17
nonfruiting 17
parasitic 19, 20, 50, 59

elm disease—cont'd

- fungi, saprophytic 19, 20, 45, 55, 59
 - species recognized 17
 - 200 specimens examined 15
- Fusarium* 2, 17, 20, 41, 50-52
 - oxysporum* 50
 - scirpi compactum* 50
- genera of fungi isolated 17
- general symptoms 6
- Gnomonia ulmea* 1
- Graphium Ulmi* 2, 58
- gummosis 28
- Helminthosporium* 17, 57, 58
- histological studies 13
- Illinois, previous outbreaks in 3
- Illinois State Nurserymen's Association, cooperates in study 2
- importance of disease, in nurseries 9
 - in cities 9
- infections, other than specific 50-58
- inoculation trials 58, 59
- investigation, methods of 12
 - of American elm 1
 - requested by chief plant inspector 3
- isolations, of fungi 12, 17
 - combinations of fungi in 19
 - 512 made 15
 - percentage sterile 18
 - 20 genera recognized in 15
- La Grange, Illinois, *Anthostomella*, *Fusarium*, *Nigrospora*, *Vermicularia* in 40, 41
- late-season symptoms 9
- leaf spot of American elm 1
- Libertyville, Illinois, *Coniothyrium* in 21
- manifestations of disease 20
- May, finds Dutch elm disease in Ohio 1
- methods of investigation 12
- Micrococcus Ulmi* 58
- Mounds City, Illinois, *Coniothyrium* in 21
- Mycosphaerella Ulmi* 1
- Nigrospora*, 17, 19, 41, 54, 55
 - sphaerica* 54, 55
- nonfruiting fungi 17
- nurseries, Freeman 61
 - Swain-Nelson 61
- nursery stock, symptoms in 6
- nurserymen's association, cooperates 2

elm disease—cont'd

- Ohio, Dutch elm disease in 1
- other infections 50-58
- outbreak, in Illinois 3
 - in Kentucky 4
 - in Massachusetts 4
- parasitic fungi 19, 20, 50, 59
- Phoma* 17-20, 41-45, 49, 59, 67
 - alternariaceum* 45
- Phomopsis* 17, 20, 45, 46, 48
- Pianeze III-b stain 13
- previous outbreaks 3, 4
- pruning 61-66
- Pseudomonas lignicola* 58
- raspberry, *Coniothyrium Fuckelii* on 37, 38
- recording data 14
- results of cultural tests 15
- Rhabdospora* 17, 57, 58
- Rockford, Illinois, unthrifty elms in 4
- Saperda tridentata*, thought to be cause of disease 3
- saprophytes 19, 20
- source of specimens 11, 15
- Sphaeropsis* 17, 18, 20, 45, 67
 - ulmicola* 45
- species of fungi recognized 17
- specific diseases 20-50
 - symptoms 8
- specimens, source of 11, 15
- spraying 61-66
- stain, Pianeze III-b 13
- state entomologist, observes dying elms prior to 1883 3
- statewide distribution of disease 9
- Stemphylium* 17-20, 51, 52
- sterile isolations 18
- stock cultures 13
- Swain-Nelson nursery, cooperates in study 2, 61
- symptoms, general 6
 - in nursery stock 6
 - of fungous parasitization 6
 - specific 8
 - late-season 9
- tannins 33
- Thielavia* 13
- tracheomycosis, associated with *Coniothyrium* spp. 20-38, 39
- treatment, heretofore unable to recommend 9

elm disease—concl'd

Ulmus americana 1, 37*campestris* 37

unthrifty elms, in Rockford, Illinois 4

Urbana, Illinois, *Coniothyrium*, *Vermicularia* in 39*Vermicularia* 17-19, 35, 36, 38-41, 67*Verticillium* 17-19, 47-50, 67*alboatrum* 48

Westerdijk and Buisman, 1929 in-vestigations 1

wild elms examined 11

Xylaria 17, 55-57

Embarrass river 476

F

fishery of the Kaskaskia river 71-123

Abramis crysoleucas 115

abundance of fishes, factors affecting 89

age determination of fishes 94

air and water temperatures 75

alligator gar 97

Allotis humilis 110*Alvordius maculatus* 119*phoxocephalus* 119*Ameirus melas* 107*natalis* 107*nebulosus* 107*Amia calva* 98*Ammocrypta pellucida* 120*Anguilla bostoniensis* 99*chrysypa* 99*Aphredoderus sayanus* 121*Aplodinotus grunniens* 113*Atractosteus tristoechus* 97

bass, large-mouth black 109

rock 94, 112

small-mouth black 109

warmouth 111

big-eyed chub 117

minnow 116

black bass, large-mouth 109

small-mouth 109

bullhead 72

crappie 113

sucker 101

blackfin minnow 115

black-head minnow 118

black-sided darter 119

blue cat 96, 105, 109

fishery of the Kaskaskia river—cont'd

bluegill 111

blunt-nosed minnow 118

Boleichthys fusiformis 120*Bolcosoma camurum* 120*nigrum* 120

boneless cat 96

bottom fauna 89

bowfin 98

brindled stonecat 119

brook lamprey 95

silverside 121

buffalo 73, 84, 88, 95, 100, 101

bullhead 73, 87, 107

black 72

minnow 117

Campostoma anamolium 118

carp 73, 84, 88, 95, 103

suckers 101

Carpiodes carpio 101*cyprinus* 101*difformis* 101*velifer* 101

cat, blue 96, 105, 109

boneless 96

channel 73, 94, 96, 106, 109

flathead 73

Fulton 73

mud 94, 108

spoonbill 73, 95, 96

tadpole 118

catches 87, 88

value 83-85

catfish 72, 84, 87, 88, 95, 118

migrations 72

Catonotus flabellaris 120*Catostomus commersonii* 101*nigricans* 101

caviar, spoonbill roe 95

Ceraticthys vigilax 117*Chaenobryttus gulosus* 111

channel cat 73, 94, 96, 106, 109

chub, big-eyed 117

flat-headed 116

Kentucky 116

Storer's 116

sucker 102

Cliala vigilax 117

collection of fishes by S. A. Forbes 71

commercial fishing 71, 73, 84, 91

common red horse 102

fishery of the Kaskaskia river—cont'd

- common shiner 115
- sucker 101
- Cottogaster shumardi* 119
- crappie, black 113
- white 74, 112
- creeks 79
- Cylindrosteus platostomus* 97
- Cynoperca canadensis* 109
- Cyprinella lutrensis* 116
- whippplii* 116
- Cyprinus carpio* 103
- dace, horned 115
- darter, black-sided 119
- fantail 120
- Johnny 120
- rainbow 120
- sand 120
- sharp-nosed 119
- snub-nosed 120
- direction of flow 74
- discharge 78
- disease of fishes 91
- dogfish 98
- Dorosoma cepedianum* 99
- doughbelly 118
- drainage basin 77, 92, 93
- drouth, recovery from 72
- drum 84, 113
- eel 99
- elevation 74
- enemies of fishes 91
- equipment and methods 80
- Ericosma evides* 119
- Ericymba buccata* 117
- Erimystax dissimilis* 117
- Erimyzon succetta oblongus* 102
- Erinemus hyalinus* 117
- storerianus* 116
- Esox vermiculatus* 108
- Etheostoma coeruleum* 120
- flabellare* 120
- jessiae* 120
- Extrarius hyostomus* 117
- factors affecting abundance of fishes
 - 89
- fantail darter 120
- fathead minnow 118
- fauna, bottom 89
- fishes, age determination of 94
- disease of 91

fishery of the Kaskaskia river—cont'd

- fishes, enemies of 91
- factors affecting abundance of 89
- hybrid 115, 116
- kinds of caught 87
- large 95-114
- of Mississippi river in Kaskaskia 73
- rate of growth 93
- small 114-21
- tagged 72
- fishing, clubs along Kaskaskia 84
- commercial 71, 73, 84, 91
- hook and line 71, 73, 91
- flathead cat 73
- flat-headed chub 116
- floodplain 79
- flow, direction of 74
- Forbes, S. A., collection of fishes by 71
- freckled stonecat 118
- frogs and turtles 83
- Fulton cat 73
- Fundulus notatus* 120
- Gambusia affinis* 121
- patruelis* 121
- gar, alligator 97
- long-nosed 97
- short-nosed 97
- gizzard shad 99
- glaciation 76, 77
- golden shiner 115
- goujon 108
- gradient 75
- grass pike 108
- grindle 98
- grinnel 98
- growth rate of fishes 93
- Hadropterus aspro* 119
- evides* 119
- phoxocephalus* 119
- headquarters 80
- Helioperca incisor* 111
- herring, toothed 99
- Hexagenia*, food of spoonbill 95
- Hiodon tergisus* 99
- hog sucker 101
- hook and line fishing 71, 73, 91
- hoop-net catches 87, 88
- Hololepis fusiformis* 120
- horned dace 115
- hornyhead 116
- Huro salmoides* 109

fishery of the Kaskaskia river—cont'd

- Hybognathus nuchalis* 117
Hybopsis amblops 117
 blennius 116
 boops 116
 deliciosus 116
 dissimilis 117
 gelidus 117
 hudsonius 116
 hyostomus 117
 kentuckiensis 116
 storerianus 116
Hyborhynchus notatus 118
 hybrids 115, 116
 hydrography 74
Hypentelium nigricans 101
Ichthyomyzon concolor 95
Ictalurus furcatus 105
 punctatus 106
Ictiobus bubalus 100
 cyprinella 100
 urus 100
 Illinois, glaciation 76, 77
 main rivers of 83
Imostoma shumardi 119
 information, sources of 83
 investigation, methods and equipment 80
 personnel 80
 Johnny darter 120
 Kaskaskia, Illinois 73, 80
 river 74, 77
 Kentucky chub 116
 kinds of fishes caught 87
 of tackle 88
Labidesthes sicculus 121
 lake lamprey 95
 lamprey, brook 95
 lake 95
 silvery 95
 large fishes 95-114
 large-mouth black bass 109
 length of Kaskaskia river 74
Lepisosteus osseus 97
 platostomus 97
 tristoechus 97
Lepomis humilis 110
 megalotis 111
 pallidus 111
Leptops olivaris 108
Lethenteron appendix 95

fishery of the Kaskaskia river—cont'd

- long-eared sunfish 111
 long-nosed gar 97
 log perch 119
Luxilus cornutus 115
 × *Hybognathus nuchalis* 116
 × *Nocomis biguttatus* 115
Lythrurus umbratilis cyanocephalus 115
Macrhybopsis gelidus 117
 mad Tom 118
 main rivers of Illinois 83
Megastomatobus cyprinella 100
 methods and equipment 80
Micropterus dolomieu 109
 salmoides 109
 migrations 72
 minnow, big-eyed 116
 blackfin 115
 black-head 118
 blunt-nosed 118
 bullhead 117
 fathead 118
 silver-mouthed 117
 silvery 117
 snub-nosed 115
 spot-tailed 116
 straw-colored 116
 sucker-mouthed 117
 top 120
 viviparous top 121
Minytrema melanops 102
 miscellaneous small fishes 120
 Mississippi river 79
 fishes in Kaskaskia 73
 moon eye 99
 moraine, Shelbyville 75
 mouth of Kaskaskia river 74
Moxostoma aureolum 102
 breviceps 103
 mud cat 94, 108
 mussels, pearls and slugs 83-86
Nocomis biguttatus 116
Notemigonus crysoleucas 115
Notropis antherinoides 115
 cornutus 115
 blennius 116
 hudsonius 116
 illecebrosus 116
 jejunus 116
 lutrensis 116

fishery of the Kaskaskia river—cont'd

Notropis pilsbryi 115
umbratilis atripes 115
whippelii 116
Noturus flavus 118
 Okaw river 71
Oligocephalus coeruleus 120
jessiae 120
Opladelus olivaris 108
Opsopocodus emiliae 115
 orange-spotted sunfish 110
 paddlefish 96
 pearls, slugs and mussels 83-86
 perch, log 119
 pirate 121
Percina caprodes 119
 personnel of investigation 80
Petromyzon marinus dorsatus 95
Phenacobius mirabilis 117
 pike, grass 108
 wall-eyed 109
Pimephales notatus 118
promelas 118
 pirate perch 121
 plankton 90
 sampling 82
Platygobio gracilis 116
 pollution 92
Polyodon spathula 96
Pomoxis annularis 112
sparoides 113
Rabida exilis 119
miurus 119
 rainbow darter 120
 rate of growth in fishes 93
 recovery from drouth 72
 red horse, common 102
 short-headed 103
 redfin 116
 river, Mississippi 73, 79
 Okaw 71
 Sangamon 74
 shiner 115
 rivers of Illinois, main 83
 rock bass 94, 112
 sand darter 120
 Sangamon river, white crappie in 74
 Sargasso sea, spawning ground of eel
 100
 sauger 109

fishery of the Kaskaskia river—cont'd

Schilbeodes exilis 119
gyrinus 118
miurus 119
nocturnus 118
Semotilus atromaculatus 115
 shad, gizzard 99
 sharp-nosed darter 119
 sheepshead 84, 113
 Shelbyville moraine 75
 shiner, common 115
 golden 115
 river 115
 spotted 117
 short-headed red horse 103
 short-nosed gar 97
 silverfin 116
 silver-mouthed minnow 117
 silverside, brook 121
 silvery lamprey 95
 minnow 117
 slender stonecat 119
 slugs, mussels and pearls 83-86
 small fishes 114-21
 small-mouth black bass 109
 smoked sturgeon 96
 snub-nosed darter 120
 minnow 115
 source of Kaskaskia 74
 sources of information on fishery 83
 spoonbill cat 73, 95, 96
 spot-tailed minnow 116
 spotted shiner 117
 sucker 102
Stizostedion canadense griseum 109
vitreum 109
 stonecat, brindled 119
 freckled 118
 slender 119
 stoneroller 118
 Storer's chub 116
 straw-colored minnow 116
 sturgeon, smoked 96
 sucker, black 101
 carp 101
 chub 102
 common 101
 hog 101
 spotted 102
 sucker-mouthed minnow 117
 sunfish 87, 88

fishery of the Kaskaskia river—concl'd
 sunfish, long-eared 111
 orange-spotted 110
 survey of Sangamon and Kaskaskia
 fisheries 85
 tackle, kinds of 88
 tadpole cat 118
 tagged fishes 72
 temperatures, air and water 75
 Tom, mad 118
 toothed herring 99
 top minnow 120
 viviparous 121
 trammel-net catches 88
 tributaries 79
 trot-line catches 88
 turtles and frogs 83
Vaillantia camura 120
 value of fishery 83
 vegetation 90
Vigil pellucidus 120
 viviparous top minnow 121
 wall-eyed pike 109
 warmouth bass 111
 water and air temperatures 75
 white crappie 74, 112
 width of Kaskaskia river 74, 77
 Wisconsin glaciation 76, 77
Xenotis megalotis 111
 Yankee Ridge 74, 75
Zygonectes notatus 120
 fishes of Illinois 473-500
 Fox river 476

G

grasshoppers—see Orthoptera
 cultivation to destroy eggs of 269
 poisoning 266
 trapping 268
 Green river 476

H

Hexagenia 90
 hybrid fishes 115, 116, 473, 482, 486-88,
 492-94
 hydroelectric plant 305

I

Illinois, main rivers of 83, 476
 river 476
 State Nurserymen's Association co-
 operates in elm disease study 2
 Illinois-Mississippi canal 476

Iroquois river 476

K

Kankakee river 476
 Kaskaskia island 79, 80
 river 71-123, 476
 Kishwaukee river 476

L

laboratory boat—see Anax
 lakes of Illinois—see fishery, fishes
 Little Wabash river 476
 Lusk creek 476

M

Mackinaw river 476
 Macoupin creek 476
 Middle Fork river 476
 Mississippi river 79, 476

N

new classification—see Plecoptera
 species—see Orthoptera, Plecoptera
 North Fork river 476
 nurseries 61

O

Ohio river 476
 Okaw river—see Kaskaskia river
 Orthoptera 125-279
 collecting localities 136
 new species 230, 237

P

Pecatonica river 476
 Pianezze III-b stain 13
 Plecoptera 281-471
 hydroelectric plant bar rack, nymph
 habitat 305
 new classification 310
 genus 417
 species 365, 423, 441, 445, 447, 455,
 459
 variety 363

R

rivers of Illinois—see by name
 principal 83, 476
 Rock river 476

S

Saline river 476
 Salt creek 476
 Salt Fork river 476
 Sangamon river 476
Saperda tridentata, thought cause of elm
 disease 3

Sargasso sea, spawning ground of eel	V
100	Vermilion river 476
Shoal creek 476	W
Skillet Fork river 476	Wabash river 476
Spoon river 476	Walsh, Benjamin Dann, first state en-
stain, Pianezze III-b 13	tomologist 281
Stoneflies—see Plecoptera	Wilt—see elm disease

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